COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

GEOLOGY OF THE ASHBY GAP QUADRANGLE, VIRGINIA

THOMAS M. GATHRIGHT II AND

PAUL G. NYSTROM, JR.

REPORT OF INVESTIGATIONS 36

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver

Commissioner of Mineral Resources and State Geologist

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GEOLOGY OF THE ASHBY GAP QUADRANGLE, VIRGINIA

By

THOMAS M. GATHRIGHT II and PAUL G. NYSTROM, JR.

ABSTRACT

The Ashby Gap 7.5-minute quadrangle is located in eastern Clarke, western Loudoun, and northern Fauquier counties in northern Virginia. This area is mainly in the Blue Ridge physiographic province; the southeast and northwest corners of the quadrangle are in the Piedmont and Valley and Ridge physiographic provinces, respectively. Bedrock within the quadrangle ranges in age from Precambrian to Middle Cambrian and has been assigned to 10 formations that have been divided into members where mappable intraformational units are present. Quaternary terrace deposits and flood-plain alluvium were also mapped.

The structural aspect of the Ashby Gap quadrangle is dominated by gently northeastward-plunging folds that include the Pigeon Hill, Franklintown, Willow Lake, and Taylors Hill synclines and the Calmes Neck and Slate Ridge anticlines. Northward-trending, eastward-dipping, high-angle reverse faults that appear to die out within the quadrangle are present, as well as northwestward-trending vertical faults of relatively small displacement. Most of the rock units are characterized by a southeastward-dipping foliation that parallels the axial planes of the folds. The very low-rank regional metamorphism evident in the more argillaceous rocks appears to be related to the development of this foliation.

Crushed stone for road aggregate and agricultural use has been produced in the quadrangle. Significant quantities of high-magnesium dolomite are present and minor amounts of siliceous iron and traces of copper, lead, and barite occur locally.

INTRODUCTION

The Ashby Gap 7.5-minute quadrangle (Plate 1) is located in eastern Clarke, western Loudoun, and northern Fauquier counties in northern Virginia. It has an area of 57.97 square miles bounded by 77°52′30″ and 78°00′ west longitudes and 39°00′ and 39°07′30″ north latitudes (Figure 1). The quadrangle is in the Valley and Ridge, Blue Ridge, and Piedmont physiographic provinces and includes portions of the Shenandoah Valley and the Blue Ridge mountains. The area contains an incised, meandering river valley in a gently rolling lowland, and a broad mountain flanked by steep sinuous ridges on the west and gently sloping lowlands on the east. The maximum elevation of approximately 1,925 feet occurs on the crest of the Blue Ridge in the south-central portion of the quadrangle, and the minimum elevation of approximately 375 feet is north of Castlemans Ferry Bridge where the Shenandoah River crosses the north boundary of the quadrangle.

The general features of the geology of the Ashby Gap quadrangle are included in Keith (1894), Butts (1933, 1940-41), and Virginia Division of Mineral Resources (1963). Studies of the geology of the Blue Ridge near Harpers Ferry, West Virginia by Nickelsen (1956) and of the Lincoln and Bluemont quadrangles, Virginia by Parker (1968) provide geologic data relevant to the Ashby Gap quadrangle. Of particular importance are geologic maps of the Berryville, Stephenson, and Boyce quadrangles, Virginia by Edmundson and Nunan (1973) and a geologic map of Clarke County by Edmundson (1945), which provide detailed stratigraphic and structural data for portions of the Ashby Gap quadrangle and adjacent areas. The field mapping of the Ashby Gap quadrangle was begun in June 1972 and completed in November 1972.

Numbers preceded by "R" in parentheses (R-4873) correspond to sample localities noted on Plate 1; those preceded by "F" (F-973) refer to fossil localities also shown on Plate 1. These

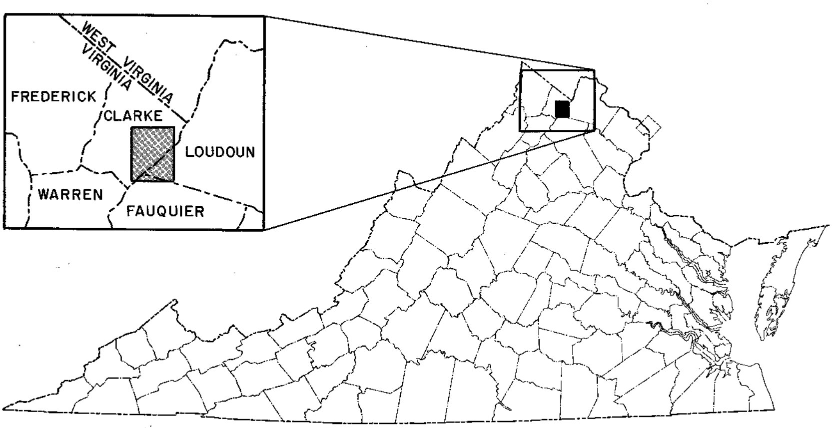

Figure 1. Index map showing location of study area.

samples and fossils are on file in the repository of the Virginia Division of Mineral Resources, Charlottesville, Virginia where they are available for examination.

The writers wish to thank James L. Calver, Commissioner of Mineral Resources and State Geologist, for his encouragement during this project and the staff members of the Virginia Division of Mineral Resources for their aid in the field and in discussion. Particular thanks are due to Raymond S. Edmundson for detailed information concerning the stratigraphy of the Cambrian rocks in the quadrangle, and to W. Edward Nunan for discussion of the structure and for several days spent in the field familiarizing the writers with the geology of the area. Thanks also go to Frank B. Click, District Materials Engineer, Virginia Department of Highways, who supplied valuable test-hole data.

STRATIGRAPHY

The rocks exposed in the Ashby Gap quadrangle are assigned to 10 geologic formations (Table 1, Plate 1). Cambrian rocks have a maximum thickness of approximately 10,000 feet; stratified Precambrian(?) rocks may be as thick as 3,200 feet and are underlain by Precambrian plutonic and intrusive rocks to an undetermined depth. Sand, silt, clay, cobbles, and gravels are present as terrace deposits and alluvium, mainly along the Shenandoah River.

Table 1.—Geologic formations in the Ashby Gap quadrangle.

Age	Name	Character	Approximate thickness in feet
Quaternary	Alluvium	Unconsolidated dark-gray sand, silt, and clay with cobble and pebble beds.	0-20
	Terrace deposits	Unconsolidated sand, clay, and pebbles in sand, silt, and clay matrix.	0-20
Cambrian	Conococheague Formation	Dark-gray, fine-grained, ribbon-banded limestone; limestone conglomerate; interbedded light-tan, medium- to coarse-grained, calcareous, quartz sandstone.	800-1,000

Age	Name		Character	Approximate thickness in feet
Cambrian	Elbrook Formation		Interbedded medium- to dark-gray, laminated limestone and light- to medium-gray dolomite; minor vari-colored shale and siltstone.	2,000±
	Rome Formation		Dark gray, yellow-weathering, argillaceous limestone; medium- to dark-gray dolomitic limestone; light tannish-gray dolomite; maroon and green shale; lesser amounts of siltstone, sandstone, and chert.	2,200±
	Shady Formation		Light- to dark-gray, cherty dolomite; very light-gray to buff, high magnesium dolomite; medium- to light-gray, locally cream-colored dolomite; dark-gray to black limestone and dolomitic limestone.	1,100-1,200
	Chilhowee Group	Antietam Formation	Tan to light-brown, feldspathic quartz sandstone; lesser amounts of light tan orthoquartzite, arkose, and sericitic phyllite.	350-500
		Harpers Formation	Dark-grayish green feldspathic graywacke and phyllite; tan orthoquartzite; ferruginous sandstone and dark purple, hematite- and magnetite-cemented, argillaceous quartz sandstone.	2,200-2,500
		Weverton Formation	Upper member: quartz-pebble conglomerate and orthoquartzite with lesser interbeds of phyllite and ferruginous sandstone. Middle member: dark gray, sandy phyllite and interbedded phyllitic quartz sandstone with minor quartz-pebble conglomerate. Lower member: light-gray, buff, and purplish-gray, very resistant orthoquartzite with interbedded sandy phyllite and quartz-pebble conglomerate.	500-600
	Catoctin Formation		Upper member: dark-green, massive metabasalt; metabasalt flow breccia; epidosite; and purple, amygduloidal slate. Lower member:	1,500-3,000

Age	Name	Character	Approximate thickness in feet
Precambrian(?)		reddish-purple tuffaceous phyllite; dark-green amygduloidal metabasalt; white, pink, and light-tan to cream rhyolitic metatuff; and epidotized, quartzose sedimentary rocks.	
	Swift Run Formation	Dark greenish-brown, locally purple, sandy and pebbly, sericitic and chloritic phyllite; locally metagraywacke and meta-arkose near basal contact.	0-200
Precambrian	Granite	Light- to very dark-gray, medium-grained, massive to moderately foliated perthitic granite, perthitic syenitic granite, and felsic augen gneiss intruded by a light-gray, very fine-grained, felsic dike.	

The Ashby Gap quadrangle is unique in that it is one of the very few quadrangles in Virginia where Precambrian through Cambrian rocks can be observed in a relatively unfaulted, well-exposed, normal stratigraphic sequence. This sequence may be separated into four divisions of genetically related rocks that include Precambrian granite, gneiss, and associated intrusives; the upper Precambrian(?) Swift Run and Catoctin formations (clastic metasedimentary and metavolcanic rocks, respectively); the Lower Cambrian Chilhowee Group (mostly detrital marine rocks); and Cambrian carbonates (marine limestones, dolomites, and fine-grained detrital rocks). Unconformities are present at the top of the Precambrian granites and gneisses, and probably at the top of the Catoctin Formation; all other rock-unit boundaries appear to be comformable.

PRECAMBRIAN ROCKS

GRANITE

Metamorphosed plutonic rocks including syenitic granite, quartz monzonite, and felsic augen gneiss are present in the southeast corner of the Ashby Gap quadrangle. The granitic rocks are similar to granitic rocks near the town of Marshall approximately

18 miles southeast of Ashby Gap, and they possibly should be included in the Marshall Formation that derives its name from this town. These rocks also may be related to the Robertson River Formation, a hornblende or biotite granite that has been traced into the northern part of the Upperville quadrangle to a point 2 miles southeast of Paris. Because bedrock exposures are rare in the southeastern portion of the quadrangle the spatial relations of the granitic and gneissic rocks are poorly understood.

In the Ashby Gap quadrangle the Precambrian granite is a light- to very dark-gray, medium-grained, very perthitic, granitoid rock that ranges in composition from quartz monzonite to syenitic granite (Figure 2). The granite is comprised of medium- to fine-grained sericitized perthite, quartz, plagioclase, and microline with irregular, fine-grained masses of clinozoisite-zoisite, epidote,

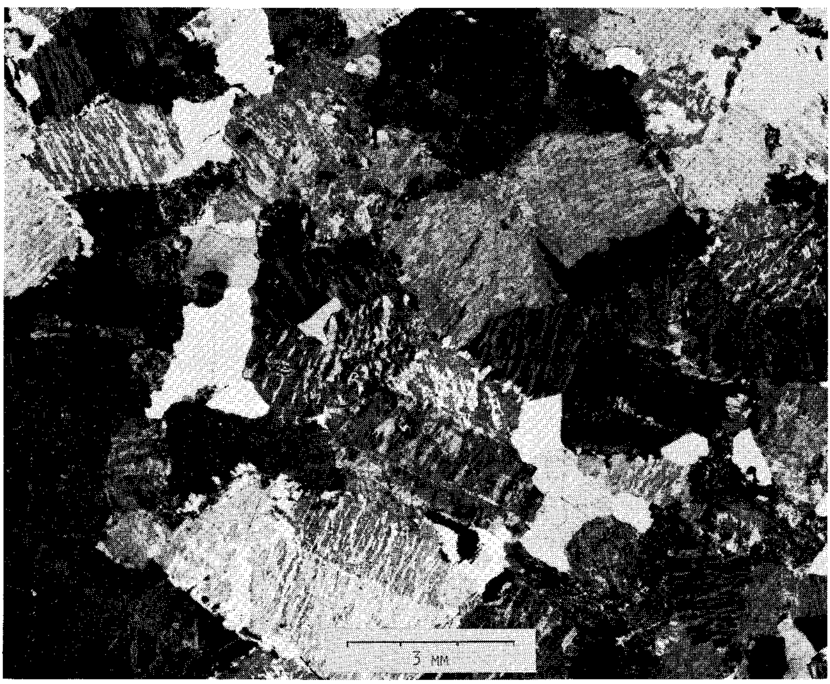

Figure 2. Photomicrograph of perthitic syenitic granite (R-5195) from Precambrian rocks, 200 feet north of U. S. Highway 50 and 700 feet east of the intersection of U. S. Highway 50 and State Road 618; crossed nicols.

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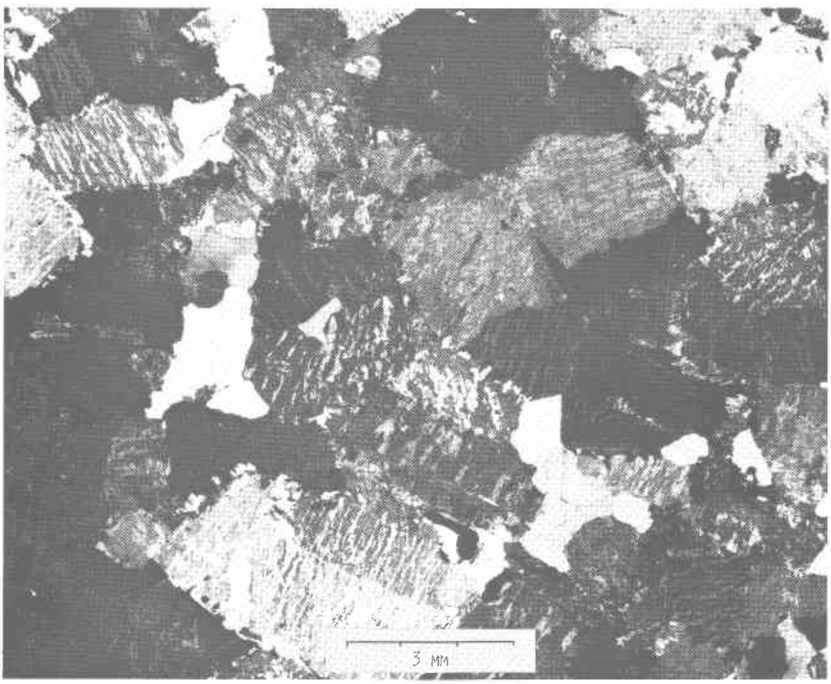


Figure 2. Photomicrograph of perthitic syenitic granite (R-5195) from Precambrian rocks, 200 feet north of U. S. Highway 50 and 700 feet east of the intersection of U. S. Highway 50 and State Road 618; crossed nicols.

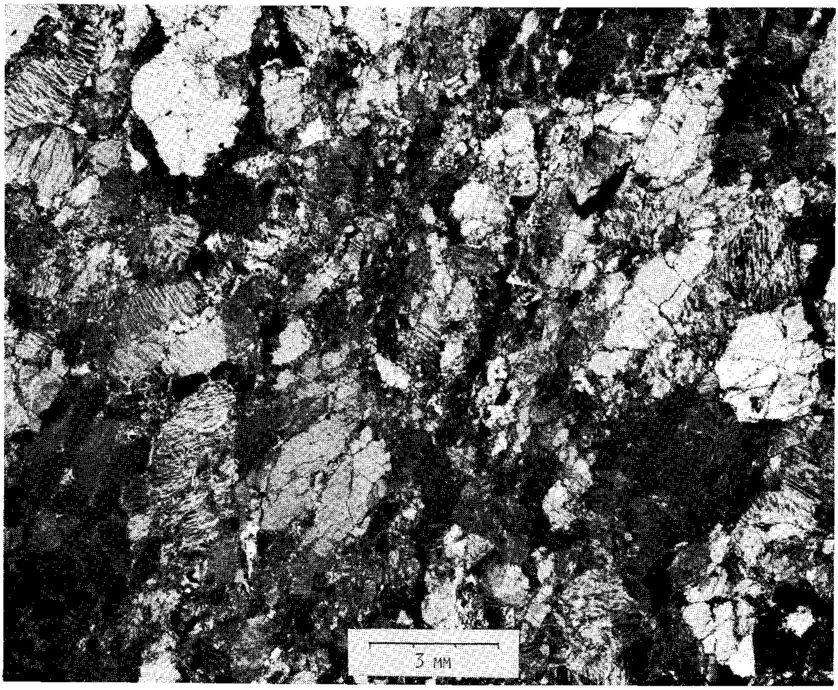
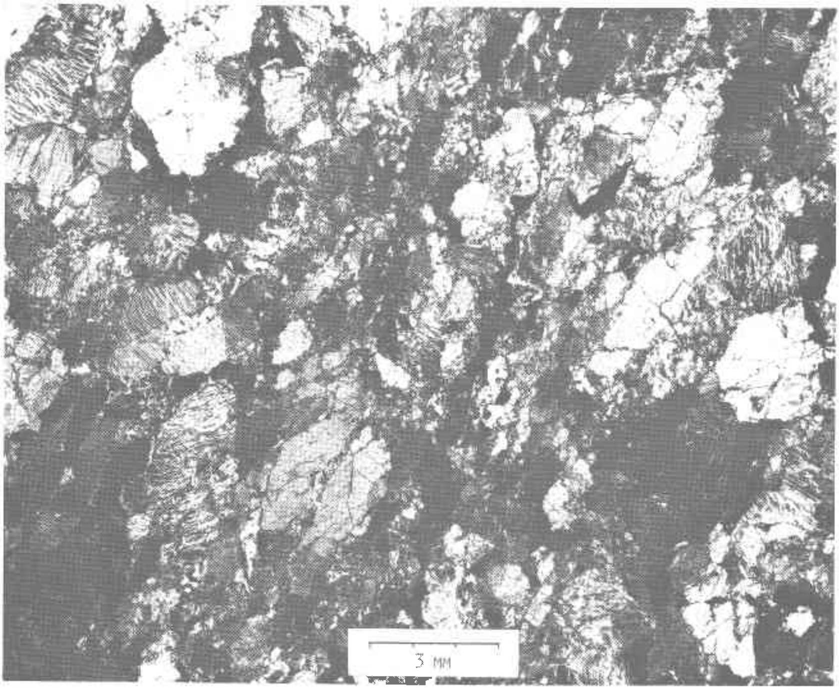


Figure 3. Photomicrograph of perthitic granite (R-5197) from Precambrian rocks approximately 1 mile north-northeast of the intersection of U. S. Highway 50 and State Road 618; fractured and crushed perthite grains with chlorite and sericite that formed in the zones of crushing typify the cataclastic texture locally superimposed on the granite; crossed nicols.

chlorite, sericite, and magnetite (and ilmenite?) and is massive to slightly foliated. The foliation consists of subparallel laminar zones of fracture in which the mineral grains are usually crushed and rotated (Figure 3). Undeformed chlorite and sericite have developed locally in the crushed zones and appear to represent the youngest mineral assemblage in the granite.

Augen gneiss comprised of large, pink perthitic feldspar augen in a fine-grained matrix of chlorite and epidote (R-5196) has been traced from the Linden quadrangle through the Upperville quadrangle to the southern boundary of the Ashby Gap quadrangle adjacent to U. S. Highway 17. This rock unit is present in the Ashby Gap quadrangle in the area shown as Precambrian granite southwest of the northwestward-trending fault that passes through Paris.



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Both felsic and mafic dikes intrude the Precambrian rocks near the southeastern portion of the Ashby Gap quadrangle. Only one dike, however, was observed in the quadrangle although many other dikes may be present (Plate 1). The felsic dike is light gray, very fine grained, and slightly porphyritic, and is composed of equigranular, anhedral quartz and feldspar (perthite) with very fine-grained secondary epidote and opaque minerals evenly distributed throughout the sample (R-5198).

Local relief on the area underlain by Precambrian rocks ranges between 30 and 300 feet, with most of the area sloping gently to the southeast. Low oblate hills, generally oriented parallel to the northeastward-trending regional foliation, occur in and just beyond the boundaries of the quadrangle. Outcrop is very sparse, saprolite ranges from 10 to 20 feet in thickness, and the flood plains of the small streams issuing from the Blue Ridge locally contain extensive deposits of weathered epidosite and metabasalt cobbles.

PRECAMBRIAN ROCKS (?)

SWIFT RUN FORMATION

In this report the Swift Run Formation is considered to include only the sericitic metasandstones and phyllites that occur between the volcanic rocks of the younger Catoctin Formation and Precambrian granites and gneisses. The Swift Run uncomformably overlies the granite, but its contact with the Catoctin may be gradational although no exposure of the contact was found in this area. The formation occurs in a narrow, discontinuous belt along the east foot of the Blue Ridge, and may not exceed 200 feet in thickness. Exposures are either very good or nonexistent, suggesting that in this quadrangle the formation is present only where it was deposited in valleys on the older Precambrian erosional surface (Reed, 1955, 1969). Accessible exposures of the Swift Run Formation occur on the east side of State Road 618, 0.6 mile north of U. S. Highway 50, and along the entrance road to Ovoka Farm, 0.4 mile west-southwest of the intersection of U. S. Highways 50 and 17 at Paris (Plate 1).

The metasedimentary rocks of the Swift Run Formation are dominantly dark greenish-brown, locally purple, sandy and pebbly phyllites with a matrix of sericite, chlorite, and microcrystalline quartz (Figure 4). Chlorite generally occurs as elongated

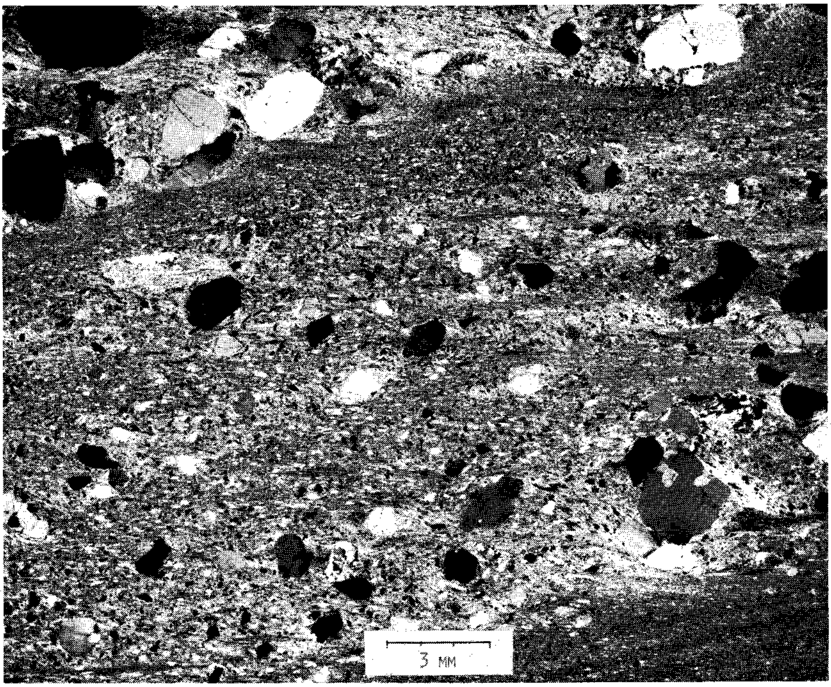
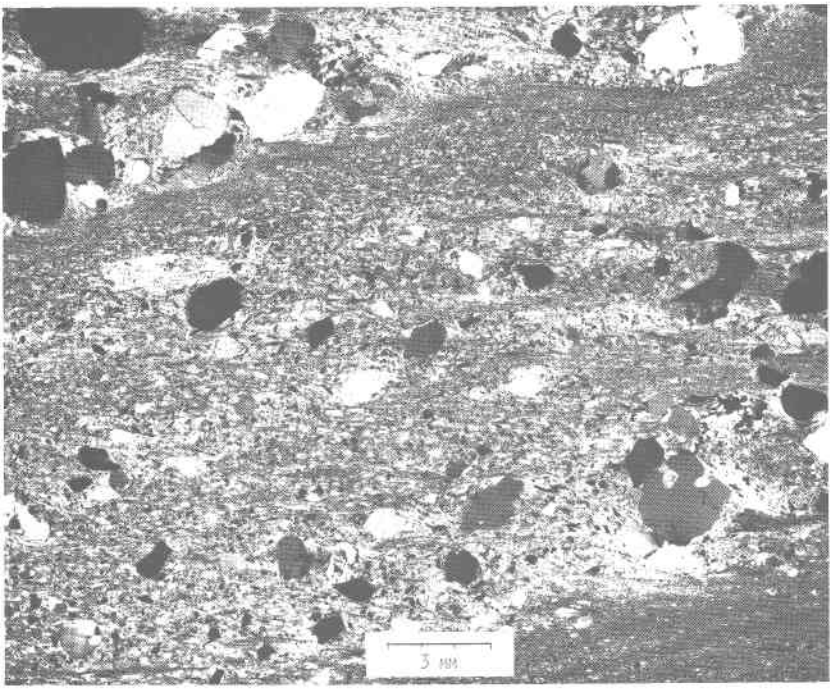


Figure 4. Photomicrograph of sandy phyllite (R-5200) typical of the Swift Run Formation from the west side of private drive 1,400 feet south-southwest of Paris; the graded bedding, poor sorting, and angular clasts are characteristic of the metagraywackes and sandy phyllites of this formation; crossed nicols.

blebs and patches, whereas the sericite and quartz are more uniformly distributed throughout the rock. Locally, near the contact with the underlying granite, coarse-grained, poorly sorted metagraywacke and meta-arkose are present. In one sample (R-5202) from the base of the formation east of Paris, conglomeratic meta-arkose is present. The pebble and sand fractions of the sample are composed largely of subangular perthite grains and fragments of perthitic granite. The gross composition of the coarse fraction of this sample differs little from the composition of nearby perthitic granites, although a quartz-sericite matrix and a few rock fragments of other lithologies are also present. Tourmaline and zircon grains and opaque minerals comprise 2 to 6 percent of the clastic fraction of the formation.



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CATOCTIN FORMATION

The main portion of the Blue Ridge in the Ashby Gap quadrangle is underlain by metabasalt and associated metavolcanic and metasedimentary rocks of the Catoctin Formation. This rock unit conformably overlies the Swift Run Formation, and uncomformably overlies Precambrian granite where the Swift Run is absent. The upper contact of the Catoctin is placed at the top of the uppermost volcanic rocks (purple slates and metabasalts) which appear to be unconformably overlain by pebbly, sericitic, metamorphosed sandstones and quartzites of the Weverton Formation. The Catoctin Formation is poorly exposed in the Ashby Gap quadrangle compared to many other areas of the Blue Ridge; epidosite talus that covers large areas masks bedrock, with most hollows on both sides of the Blue Ridge being choked with angular blocks of epidosite and metabasalt. The 15 to 20 feet of colluvium and saprolite exposed in borrow pits on the south side of State Road 601 approximately 1.3 miles northeast of Ashby Gap may characterize the overburden present on the metabasalts in the more gently sloping areas of the Blue Ridge. Although the lack of adequate exposures did not permit an accurate estimate to be made for the thickness of the Catoctin Formation in this quadrangle, a probable thickness of between 1,500 and 3,000 feet is inferred from structural data obtained from the sparse outcrop.

The Catoctin Formation is herein divided into two members, which are mapped separately (Plate 1). A *lower member* is composed of approximately 500 feet of interbedded reddish-purple tuffaceous phyllite; dark-green amygduloidal metabasalt; white, pink, and light-tan to cream rhyolitic metatuff; and epidotized, quartzose metasedimentary rocks. A much thicker, *upper member* is composed of 1,000 to 2,500 feet of dark-green, massive metabasalt, metabasalt flow breccia, epidosite, and a few interbeds of purple amygduloidal slate. The boundary between the upper and lower members is placed at the top of very fine-grained, white, pink, and cream, locally epidote-bearing, rhyolitic metatuff. This bed reaches a maximum thickness of about 30 feet in the quadrangle and appears to be present discontinuously on the west flank of the Blue Ridge anticlinorium from Linden in Warren County (Linden 7.5-minute quadrangle) to Bluemont in Loudoun County (Bluemont 7.5-minute quadrangle), and it may be present on the east flank of the anticlinorium in the Oatlands area of

Loudoun County (Parker, 1968, p. 14). Few exposures of the lower member of the Catoctin Formation are accessible in the Ashby Gap quadrangle, but amygduloidal metabasalt and purple tuffaceous phyllites and metatuffs are partially exposed for 1,500 feet along the north side of U. S. Highway 50 east of its intersection with U. S. Highway 17. The rhyolitic metatuffs and phyllites are exposed in new roadcuts on the north side of State Highway 7 at Bluemont in Loudoun County. Accessible exposures of the upper member of the formation occur along State Road 601 approximately 0.5 mile north of Ashby Gap. Very good exposures of the purple amygduloidal slate, the Loudoun Formation of Butts (1933), King (1950), Nickelsen (1956), and Allen (1963, 1967), occur at the southwest end of State Road 602.

Zircon age dates obtained from rhyolites in the lower Catoctin Formation of Pennsylvania have established an age of 820 million years (late Precambrian) for that portion of the unit (Rankin and others, 1969). In the Ashby Gap quadrangle, rhyolitic tuffs that may be related to the Catoctin rhyolites of Pennsylvania suggest a similar age for that portion of the Catoctin Formation in Virginia.

Petrography: Metabasalts, either amygduloidal, porphyritic, or massive, comprise most of the upper member of the Catoctin Formation. The metabasalts are dense, dark-green, fine-grained rocks that are characterized in thin section by randomly oriented plagioclase laths in a very fine-grained matrix of actinolite, epidote, chlorite, and magnetite (and ilmenite?). Amygdules that generally range from 1 to 5 mm in diameter are concentrated near the tops or bottoms of the metabasalts (Reed, 1969). The amygdules are composed of either quartz and feldspar; quartz, feldspar, and epidote; or quartz, feldspar, epidote, and chlorite and rarely contain opaque minerals (Figure 5). Phenocrysts of plagioclase that range from 1 to 5 mm in length occur in the rare porphyritic metabasalts.

Purple amygduloidal slates or phyllites occur in the uppermost part of the Catoctin Formation and sparsely throughout the upper member as thin, discontinuous layers. In thin section the strongly foliated matrix of these slates is composed of very fine-grained sericite, microcrystalline quartz, and magnetite-ilmenite (with associated hematite and leucoxene). Throughout this matrix are scattered amygdules of quartz and sericitized feldspar or sericite that, similar to the amygdules in the metabasalts, rarely contain

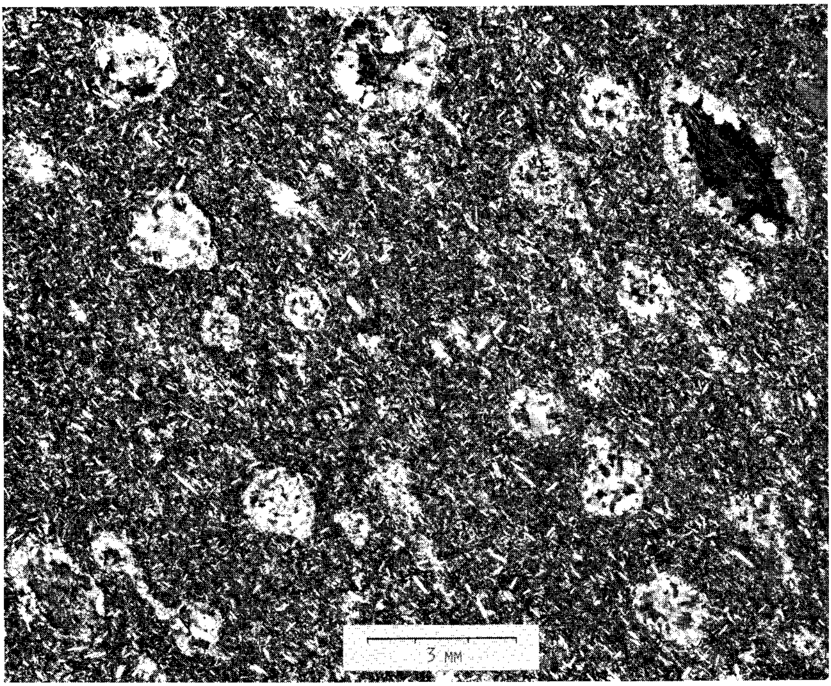
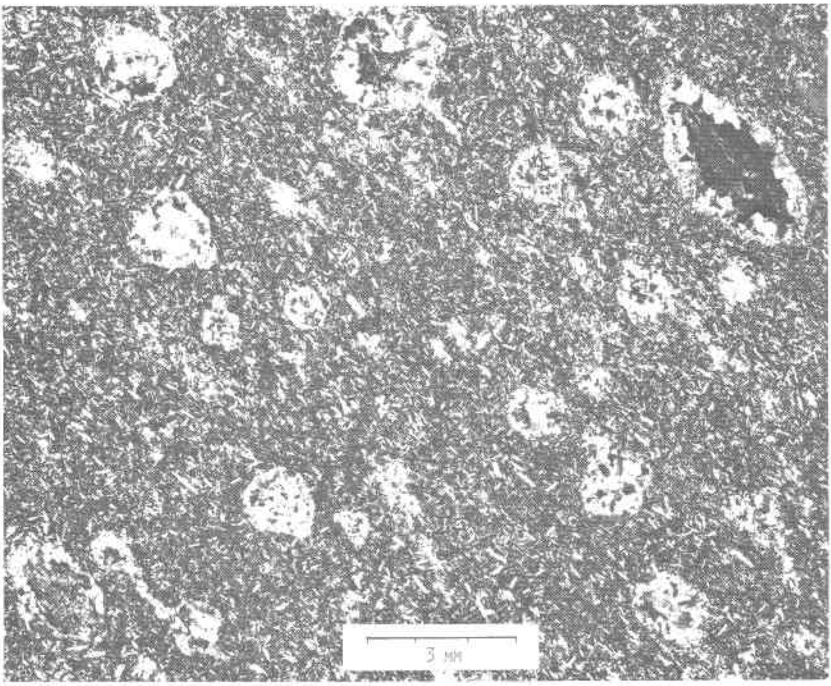


Figure 5. Photomicrograph of amygduloidal metabasalt (R-5203) of the Catoctin Formation 1.5 miles east-northeast of Paris; quartz-epidote-chlorite amygdules in a metabasalt groundmass of randomly oriented plagioclase laths, actinolite, epidote, chlorite, and magnetite (and ilmenite?); crossed nicols.

opaque minerals (Figure 6).

The cream-colored, very fine-grained rhyolitic metatuff that occurs in the lower member of the Catoctin Formation is composed of irregular aggregations of fine- to medium-grained, locally epidotized quartz and feldspar (pumice fragments?) in a strongly folliated matrix of very fine-grained sericite and microcrystalline quartzo-feldspathic material. Euhedral phenocrysts of plagioclase and a few fragments of basic volcanic rock are also present as clasts in the matrix (Figure 7).

Pale yellow-green, dense, fine-grained epidosite (epidote-quartz rock) occurs throughout the Catoctin Formation as an early chemical-alteration product of the metabasalt (Reed and Morgan, 1971), as vein fillings, and as cementing material in metabasalt flow breccias and quartzose sandstones interbedded with the basalt flows. In thin section the epidosite is composed of very fine-



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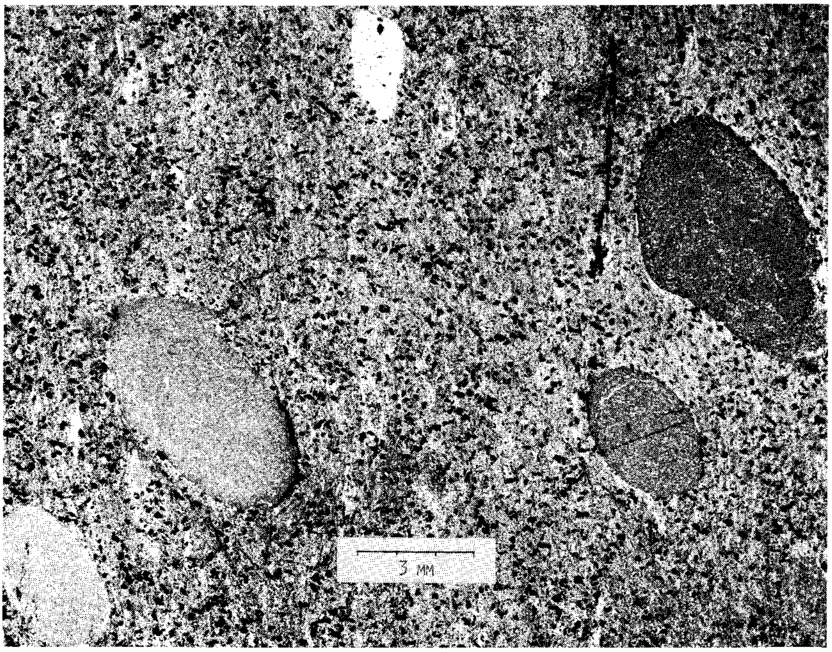


Figure 6. Photomicrograph of purple amygduloidal slate (R-5204) from the uppermost part of the upper member of the Catoctin Formation at the southwest end of State Road 602; amygdules are of sericite and microcrystalline quartz in a groundmass of sericite, microcrystalline quartz, and magnetite-ilmenite; crossed nicols.

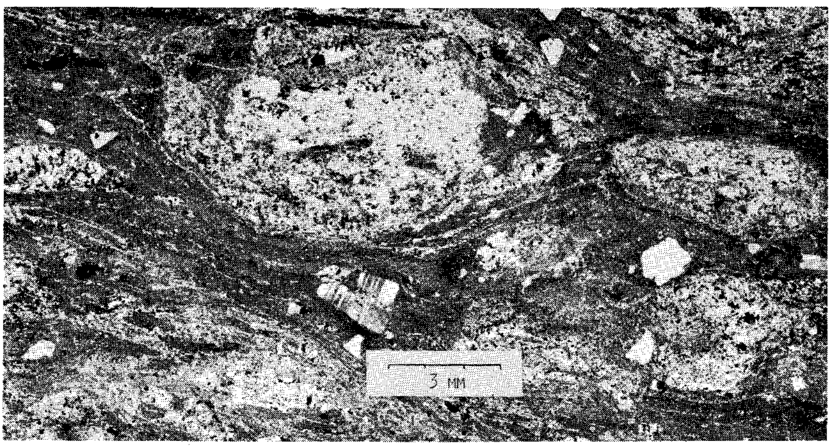
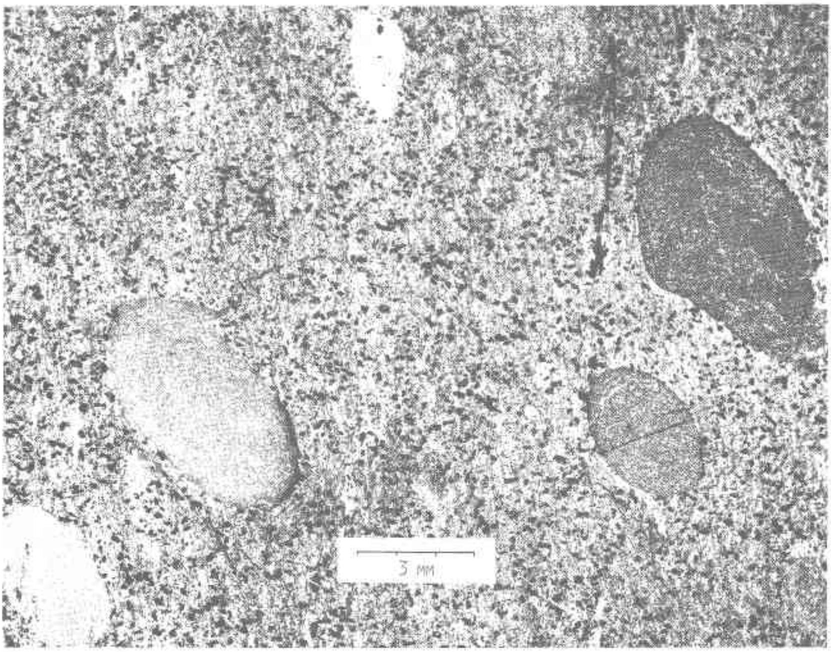


Figure 7. Photomicrograph of rhyolitic metatuff (R-5205) of the lower member of the Catoctin Formation from the east foot of the Blue Ridge, 1.8 miles north-northwest of the intersection of State Roads 619 and 766, and 1,700 feet southwest of Llangollan Farm buildings; quartzo-feldspathic masses (light gray, ovoid forms) and plagioclase phenocrysts occur in foliated quartz-feldspar matrix; crossed nicols.



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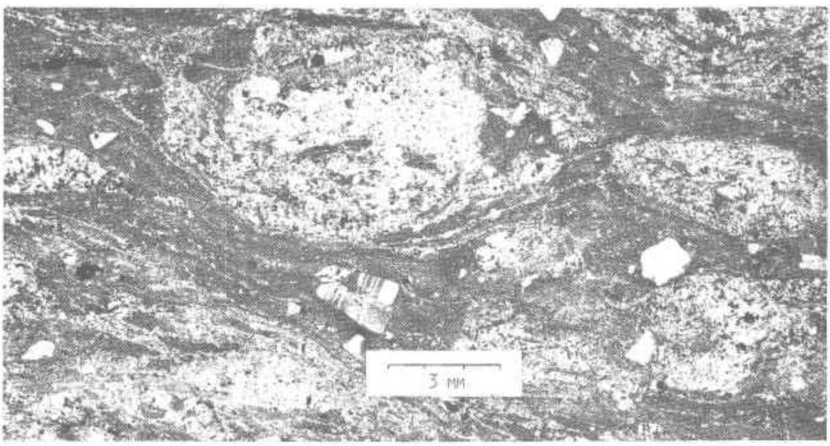

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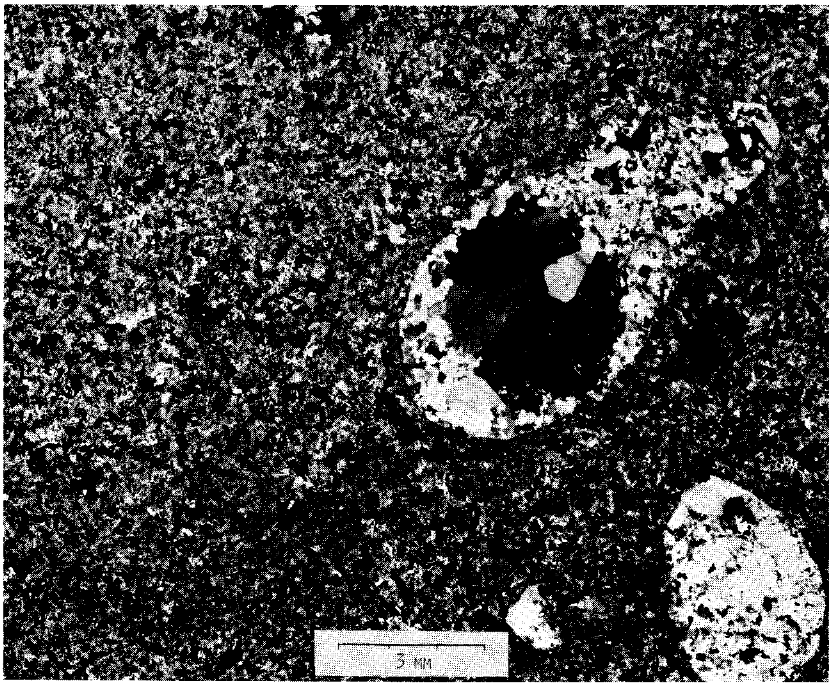
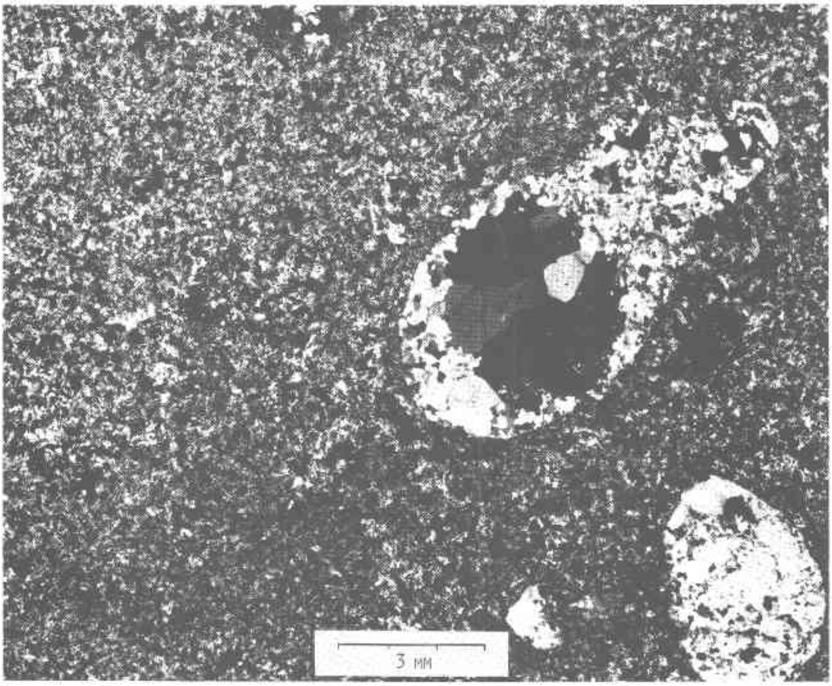


Figure 8. Photomicrograph of amygduloidal epidosite (R-5206) of the Catoctin Formation, 1.5 miles east-northeast of Paris; quartz-epidote amygdules occur in a groundmass of epidotized metabasalt (darker gray areas); crossed nicols.

grained, equigranular, subhedral epidote and aggregates of anhedral quartz. Where metabasalt has been altered to epidosite a relict basaltic texture may be preserved and amygdules are commonly little altered (Figure 8).

CAMBRIAN SYSTEM

The Chilhowee Group of Early Cambrian (possibly late Precambrian) age, consisting of metamorphosed sedimentary rocks having an aggregate thickness of 3,050 to 3,600 feet, overlies the Catoctin Formation and underlies the Cambrian carbonate sequence of the Shenandoah Valley. (*All rocks in the Ashby Gap quadrangle have been somewhat metamorphosed. However, the general character of the Chilhowee Group and the overlying carbonate rock units is dominantly sedimentary rather than*



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In the northern Blue Ridge the detrital marine sedimentary rocks (Schwab, 1970, 1971) of the Chilhowee Group have been divided into the Weverton, Harpers, and Antietam formations. Resistant, slightly metamorphosed quartz sandstone, quartz-pebble conglomerate, sericitic quartz sandstone, ferruginous quartz sandstone, arkosic quartz sandstone, phyllite, and sandy phyllite occur in varying proportions in each of these formations. These rocks have been closely folded and locally faulted; the more argillaceous beds have well-developed, moderately to closely spaced, axial-plane cleavage. Original clays have been altered to sericite and chlorite. Quartz grains in the sandstones commonly have well-developed deformation lamellae, and locally grains have been crushed.

The land underlain by rocks of the Chilhowee Group is steep, forest covered, and rocky. Linear and sinuous ridges are formed by the resistant sandstones of all three formations, and slopes of 10 to 30 degrees are common on each with more gently sloping land surfaces occurring locally on the Harpers Formation. Thin quartzite talus deposits are formed downslope from ridge-making, resistant rock ledges. Along the southeast side of the Shenandoah River on the west side of Slate Ridge, slope angles of 32 to 35 degrees occur where talus from Harpers quartzites creeps downslope to a corrading river bank. These talus deposits are composed of quartzite blocks that range up to 16 inches in length and appear to be lying on the slope near the angle of repose since any disturbance will initiate small slides and boulder rolling. Where quartzite ledges of the Weverton Formation exceed 15 to 20 feet in thickness, small cliffs and benches that partially define northeastward-plunging fold structures are readily visible on stereo-pair aerial photographs. The small streams that cross these formations usually flow through thin deposits of quartzite derived from the resistant strata of the Chilhowee Group and basalt cobbles and boulders from the Catoctin Formation to the east. Surface run-off from heavy rains during tropical storm Agnes in June 1972 transported much cobble debris in even the smaller streams, and imbricate sedimentary structure in cobble and pebble deposits was formed locally in the stream beds.

Limestone, dolomite, and shale of Cambrian age overlie the Chilhowee Group and make up a total thickness of between 6,100 and 6,400 feet of strata in the lowlands along the Shenandoah River and to the west. This sequence of shallow-water, marine sedimentary rocks includes the Shady, Rome, Elbrook, and Conococheague formations. All boundaries between these formations are somewhat arbitrary since the lithologic changes between them are gradational. The stratigraphic nomenclature and formational contacts of these formations as used in this report essentially agree with those of Edmundson and Nunan (1973) in adjacent quadrangles to the north and west. The carbonate terrane has a relief of slightly more than 200 feet in the study area and is intricately dissected along the Shenandoah River. Karst development is minimal, and landforms developed on the carbonate rocks commonly relate directly to the attitude and resistance of the immediately underlying bedrock. Relatively resistant shale and sandstone beds occur in the dominantly carbonate strata of the Rome, Elbrook, and Conococheague formations. Low ridges developed on these resistant beds form a sinuous pattern that delineates the northeastward-plunging asymmetric fold structure present in the carbonate sequence. Only where undissected terrace gravel deposits are present is the effect of bedrock stratigraphy and structure on landform development nullified.

CHILHOWEE GROUP

Weverton Formation

The Weverton Formation overlies the Catoctin Formation along a probable erosional unconformity, and is overlain conformably by the Harpers Formation. Between 15 and 20 percent of the Weverton is orthoquartzite, quartz-pebble conglomerate, and pebbly quartz sandstone; the remainder is pebbly, very sericitic quartz sandstone, phyllite, and sandy phyllite. The formation is approximately 500 to 600 feet thick and is herein divided into three members that are mapped separately in order to better define structural features (Plate 1). The *lower member* is composed of a sequence of mostly medium- to coarse-grained quartzite and pebbly to sandy phyllite about 150 feet thick, including two or three resistant, ledge-forming quartzite beds 10 to 40 feet thick. The relatively nonresistant *middle member* is composed mostly of pebbly to sandy phyllite and sericitic quartz sandstone about 300 feet thick. The *upper member* is composed mostly of pebbly orthoquartzite and quartz-pebble conglomerate approximately 100 feet thick.

The quartzites of the Weverton Formation are the most resistant lithologies in the study area, and along the west base of the Blue Ridge they form steep, sinuous ridges that are divided into subequal segments by crosscutting streams. The resistant lower and upper members are generally well exposed, but talus and deep weathering conceal the middle member in most areas. Structural and stratigraphic influences on the development of topographic features is well displayed by the closely folded Weverton quartzites. Streams usually cross the formation only where nearly vertical fold limbs or faults are present, and tend to meander northeastward around the northeastward-plunging, quartzite-capped anticlines. Hill crests are commonly underlain by synclinal folds of the quartzite ledges of the lower member, and the highest ridge elevations occur where the quartzites of this member are thickest.

Excellent exposures of the upper member are accessible at Mount Carmel Church just northeast of the intersection of U. S. Highway 50 and State Road 606. Very good exposures of the lower member occur on the ridge to the northeast of the church. On State Road 602, 1.5 miles south of its intersection with U. S. Highway 50, the contact between the Weverton and Catoctin formations is exposed along an intersecting farm road. There appears to be little change in character or thickness of the formation within the quadrangle although the individual resistant ledges locally diverge, pinch out, or coalesce.

The two or three sandstone ledges of the lower member are light-gray, buff, or purplish-gray, very resistant orthoquartzites; they are composed of medium- to coarse-grained, moderately to well-sorted, originally well-rounded quartz sand with 3 to 8 percent matrix of sericite and microcrystalline quartz (Figure 9). Pressure-solution activity has modified quartz-grain boundaries and destroyed original permeability. Fine-grained, detrital mag-

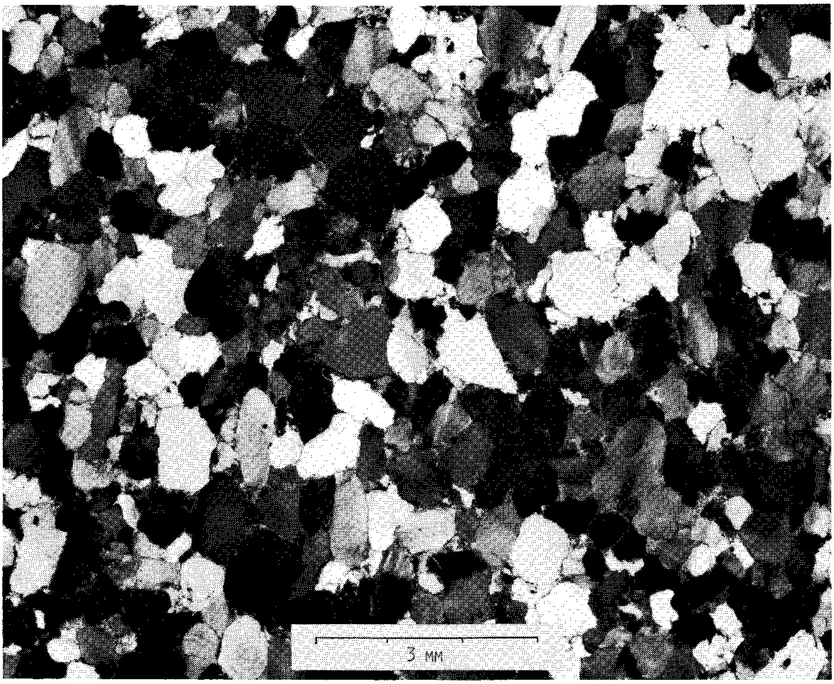
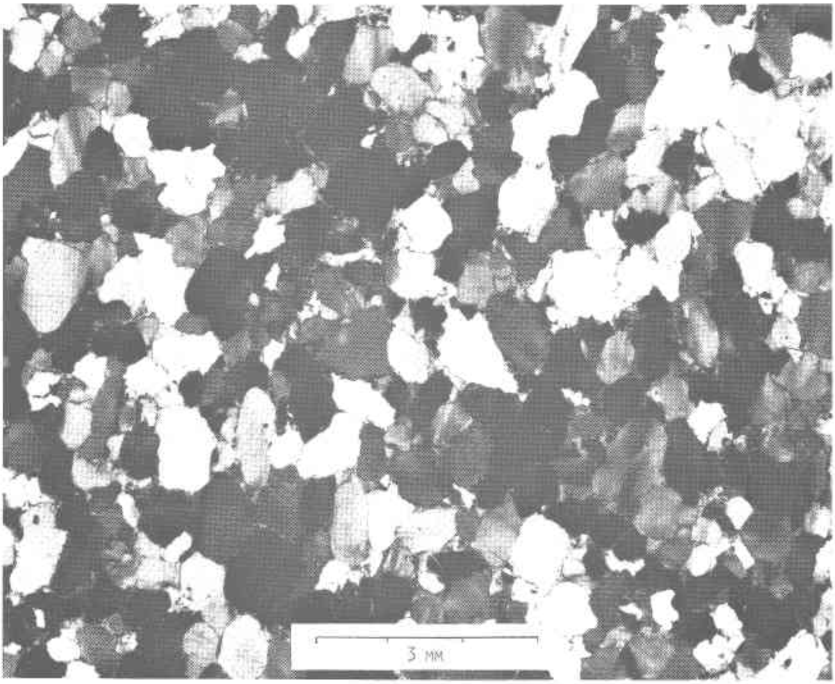


Figure 9. Photomicrograph of quartzite (R-5207) from the lower member of the Weverton Formation, 0.7 mile east-southeast of the intersection of State Roads 606 and 649 on north side of Rod Hollow. Medium- to coarse-grained, relatively mature, quartz sandstone with silica cement (quartz overgrowths) is characteristic of the lower member of the Weverton Formation in the Ashby Gap quadrangle.

netite, hematite, ilmenite, tourmaline, and zircon range from a trace to over 10 percent in some beds. Pebbly and sandy phyllite is interbedded with the orthoquartzites. Quartz-pebble conglomerates are present locally in the lower member and commonly contain subrounded to well-rounded pebbles.

Sericitic, locally pebbly, quartz sandstones, phyllites, and sandy phyllites form the middle member of the Weverton Formation and interbeds in the upper and lower members. The sandstones consist of subangular to subrounded quartz sand and pebbles, are poorly sorted, and have a chlorite-sericite matrix. The shales, where unweathered, are very hard, very dark grayish green and dark purplish gray with a few quartz-pebble conglomerate and sandstone interbeds.

The upper member consists of one, and locally two, ledge-



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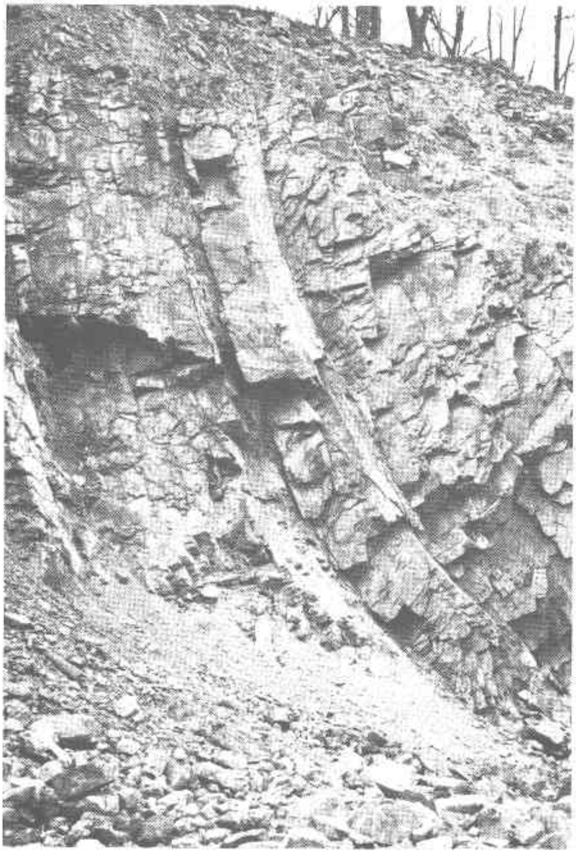
The upper member consists of one, and locally two, ledge-

Figure 10. Upper member of the Weverton Formation as exposed on the south side of State Highway 7, 0.5 mile west of Snickers Gap near the crest of the Blue Ridge in the Bluemont quadrangle. This and adjacent exposures exhibit pebbly, quartz sandstone; ferruginous, sericitic, quartz sandstone; and arkosic, quartz sandstone.

forming units of pebbly orthoquartzite; quartz-pebble conglomerate; and interbedded phyllite, ferruginous sandstone, and pebbly, sericitic quartz sandstone (Figure 10). These rocks may have well-defined cross bedding and scour-and-fill structure, or may be massive. Iron-oxide cement is common in the upper ledge in which it outlines bedding or lends a dark, purplish-gray, mottled appearance to the outcrop. The quartz sandstones of the



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Harpers Formation

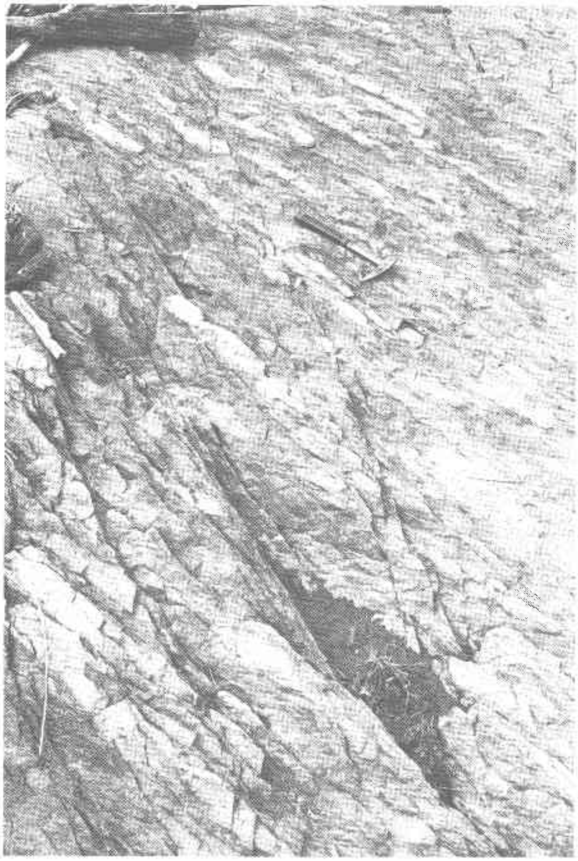
The Harpers Formation conformably overlies the Weverton Formation and is conformably overlain by and grades into the Antietam Formation. In this report the base of the Harpers Formation has been placed at the top of the uppermost resistant ledge of quartz-pebble conglomerate or ferruginous pebbly-quartz sandstone of the Weverton Formation. The contact between the Harpers and the overlying Antietam Formation is placed at the base of the continuous sequence of light-tan, medium- to thin-bedded, *Scolithus*-bearing feldspathic sandstones above the dark-green, feldspathic graywacke and shale or phyllite sequence typical of the Harpers Formation.

The Harpers Formation is estimated to be between 2,200 and 2,500 feet in thickness and is largely a monotonous sequence of laminated to thick-bedded, dark grayish-green, very fine-grained, phyllitic, feldspathic graywackes with a few ledge-forming, medium- to thick-bedded, coarse-grained quartz sandstones and quartzites near the top. A few dark-purple, magnetite- and hematite-cemented, sericitic, argillaceous quartz sandstone beds also occur in the upper and middle portions of the formation; some of these are mapped separately on Plate 1. In thin section typical Harpers sandstone (R-5208 and R-5209) is composed of 50 to 60 percent very fine-grained quartz, plagioclase, orthoclase, and perthite clasts of which the quartz clasts comprise about 80 percent of the sand fraction. A few percent of opaque minerals (magnetite-ilmenite) and traces of tourmaline and zircon are also present. The matrix is principally sericite with a lesser amount of chlorite that occurs as small discrete masses and as intimate integrowths with the sericite. Intergrowth of sericite and chlorite with the quartz and feldspar clasts is apparent along grain-matrix boundaries. Because of the well-developed axial-plane cleavage typical of lithologies in the Harpers Formation, bedding features are locally obscure and difficult to interpret (Figure 11). Where thin sandstone beds are present as bedding markers, slip of more than 1-inch displacement is common along spaced cleavage planes.

The lower 150 to 200 feet of the formation is composed of dark-

Figure 11. Typical bedding-surface exposure of the Harpers Formation on the south bank of the Shenandoah River approximately 1.3 miles northeast of Lewin Hill. The pseudobedding features trending across the outcrop from upper left to lower right are formed by narrow, linear, wedge-shaped remnants of a thin but originally continuous quartzose sandstone bed. The bed, vertically offset along many slip-cleavage surfaces during folding, was subsequently eroded leaving only the wedge-shaped remnants preserved on the downthrown side of the slip cleavage planes. Where exposures are poor these features may be misidentified as true bedding.

gray phyllite that has a faint-purple cast. Exposures of this lithology occur on the east side of State Road 649 at the mouth of Rod Hollow. Four locally discontinuous tan, medium- to coarse-



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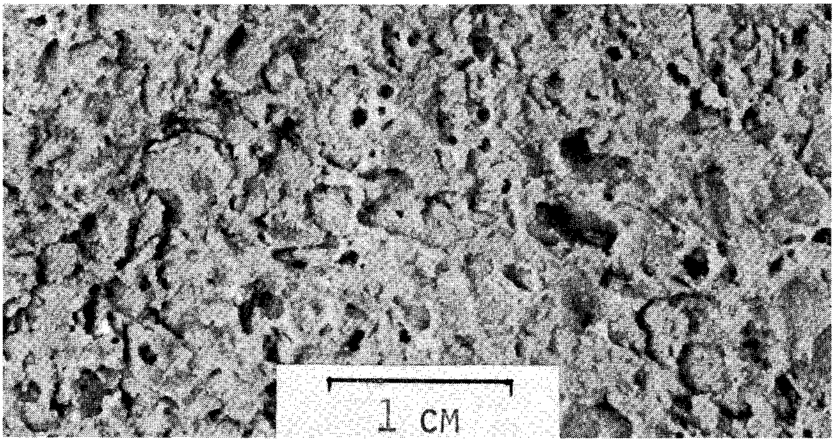
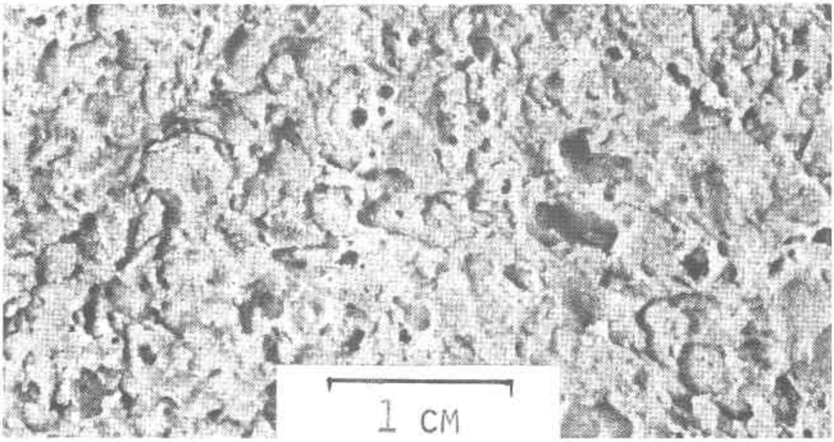


Figure 12. Probable fossil shells and shell fragments from the upper part of the Harpers Formation. This sample was obtained from sandstone talus on the east side of a private drive, 0.75 mile northeast of the east end of Castlemans Ferry Bridge in the Berryville 7.5-minute quadrangle. Material consists of casts of convexo-concave, round, low-relief, shell-like forms ranging from 4 to 6 mm in diameter in light gray, medium-to coarse-grained, mature quartz sandstone. Shell-like forms locally have preferred bedding orientation with convex side up, and are commonly associated with other unidentified, probable organic forms.

grained quartzites or impure, ferruginous, quartz sandstone beds are mapped separately on Plate 1. The upper two are quartzite ledges and are somewhat thicker bedded and coarser grained than the sandstone of the Antietam Formation, but are otherwise quite similar. *Scolithus* tubes (sand-filled, nearly vertical worm borings?) occur locally in all four sandstones and many unidentified probable fossile fragments (Figure 12) have been found in the upper quartzite member west of Taylors Hill. The quartzite beds in the Harpers Formation decrease in thickness, number, and resistance to erosion from southwest to northeast across the quadrangle. South of U. S. Highway 50 near Berrys, two coarse-grained, locally conglomeratic quartz sandstone beds, 10 to 30 feet thick, occur as ledges on or near the ridge crests. East of Willow Lake near the center of the map area, only one bed, 10 to 15 feet thick, is present and north of Taylors Hill it may be discontinuous. The impure, ferruginous quartz sandstone beds range up to 15 feet in thickness and appear to become thinner to the northeast. The upper bed is overlain by a discontinuous, coarse-grained, *Scolithus*-bearing, sericitic quartz sandstone



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Antietam Formation

The Antietam Formation is the youngest formation of the Chilhowee Group. It is conformably underlain by and grades into the Harpers Formation, and appears to be conformably overlain by the Shady Formation although this contact is generally obscured by Antietam-quartzite talus. The Antietam Formation

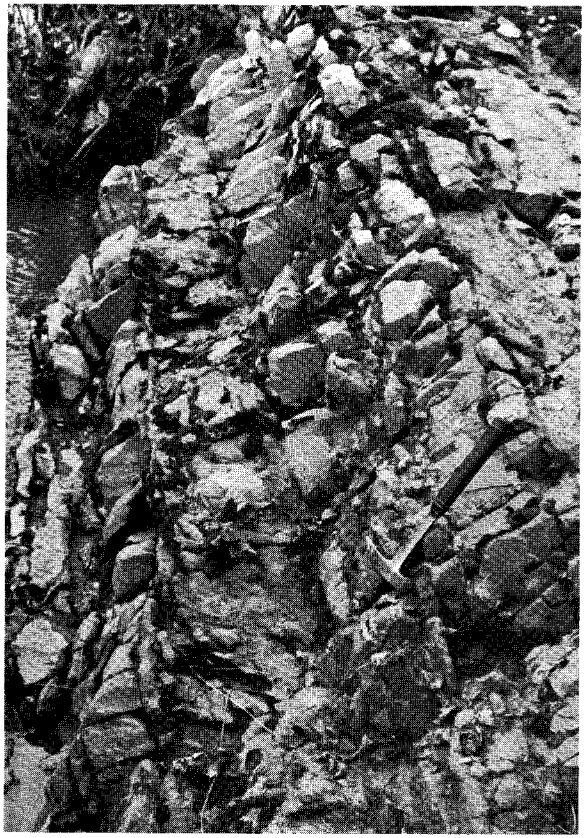

Figure 13. Antietam Formation as exposed on the south side of the Shenandoah River along State Road 606 at the northeast end of Lewin Hill. The medium to thin beds of quartz sandstone with subequal amounts of fine-grained, sericitic and arkosic, quartz sandstone beds are characteristic of the Antietam Formation in this area.

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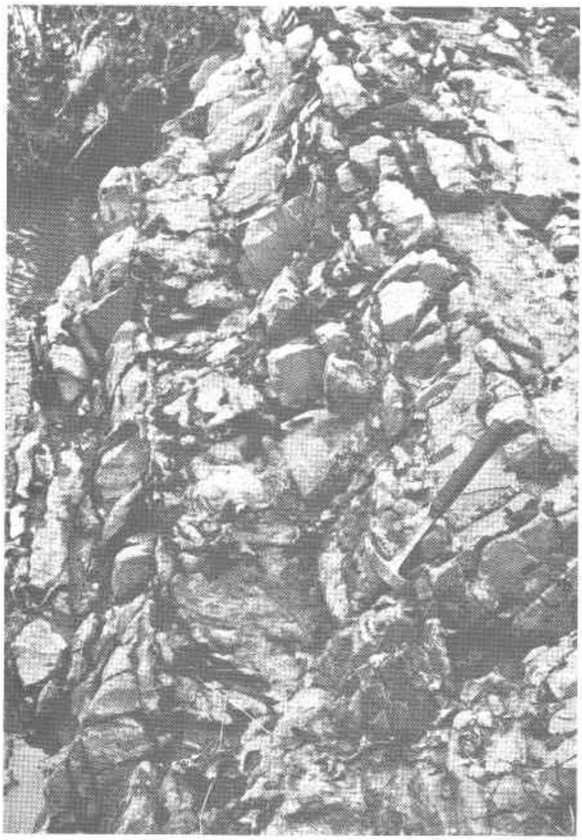

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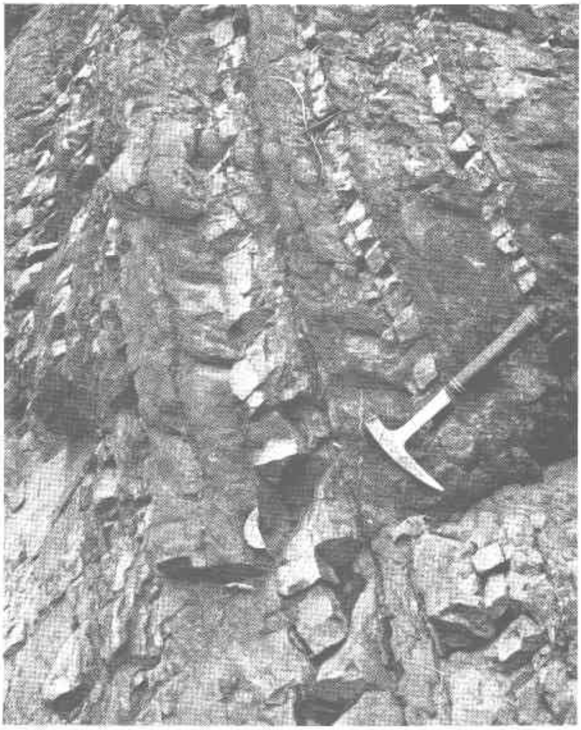
Figure 14. Lowermost beds of the Antietam Formation near the contact with the Harpers Formation as exposed on the south side of the Shenandoah River approximately 300 feet east of exposures shown in Figure 13. These exposures characterize the transitional nature of the beds between typical Harpers graywacke and Antietam quartz sandstone lithologies.

forms low, sharp-crested ridges west of the main portion of the Blue Ridge, and appears to be 350 to 500 feet thick in the Ashby Gap quadrangle. It is composed of tan to light brown, fine- to very fine-grained, well-sorted, sericitic, feldspathic quartz sandstone interlayered with lesser amounts of light tan, medium- to fine-grained arkose, orthoquartzite, and very fine-grained, sandy, sericitic phyllite (R-5210, R-5211, R-5212, R-5214, R-5215, R-5232).

Natural exposures of the Antietam Formation are rare due to the lack of the thick, ledge-forming quartzite beds so common to the formation southwest of this area and because in most areas the formation is covered by quartzite talus. The best exposures



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Natural exposures of the Antietam Formation are rare due to the lack of the thick, ledge-forming quartzite beds so common to the formation southwest of this area and because in most areas the formation is covered by quartzite talus. The best exposures are on the north side of State Road 621 approximately 1.5 miles east of Lockes Landing (Appendix, Section 1), and on each side of State Road 606 approximately 0.4 mile south of the location of Section 1 on the south side of the Shenandoah River (Figures 13, 14). Exposures of the formation for 1 mile south of Castlemans Ferry Bridge and those north of Byrd Bridge are very poor, and the formation boundaries and structures shown on Plate 1 are highly interpretive in these areas.

Primary structures in the Antietam Formation include small, very low-angle cross-laminations, quartz-pebble lenses, and scour and fill. The formation is characterized by thin- to medium-bedded, subparallel, planar sandstone beds separated by thin beds or laminae of phyllite or shale. The upper few tens of feet of the formation are friable, coarse-grained, quartz sandstone with late secondary iron-oxide cement. Laminated to massive, locally vuggy limonite and limonite nodules are present in the residual soil along the Antietam-Shady contact. On State Road 606 approximately 800 feet north of Morgan Mill Stream a 3- to 5-foot-thick limonite- and hematite-bearing clay zone is present between steeply dipping, friable, iron-oxide-cemented sandstone of the Antietam Formation and a red-mottled, yellow saprolite apparently formed from carbonate rocks of the Shady Formation. Small pits along the Antietam-Shady contact, mostly southwest of Willow Lake in the Willow Lake syncline, are evidence of early attempts to exploit iron or manganese ore from this contact zone.

The Chilhowee Group is sparingly fossiliferous. *Scolithus* tubes are commonly found in the more quartzose sandstones of the Antietam and Harpers formations. In addition to *Scolithus* tubes, molds of probable fossil shell fragments are present in coarse-grained, calcareous?, quartz sandstone lenses of both formations although no identification has been made of those fragments to date. Many subhorizontal, burrow-like features occur in the argillaceous sandstone beds of the lower Antietam (Appendix, Section 1). A cast of a strongly ribbed brachiopod was found on the north crest of Taylors Hill in talus from a sandstone of the Antietam Formation.

The Antietam Formation appears to decrease in thickness from southwest to northeast across the quadrangle in a manner similar to the sandstones of the Harpers Formation. Ferruginous standstones and drab-green, sandy shales or phyllites occur in the lower part of the Antietam Formation northeast and east of

State Road 621 on the northwest flank of the Taylors Hill syncline, suggesting that the lower portion of the formation may grade laterally into rocks characteristic of the Harpers Formation to the northeast.

SHADY FORMATION

The Shady Formation appears to conformably overlie the Antietam and grades upward into the overlying Rome Formation. The contact with the Antietam appears to be gradational over a few tens of feet in which dark-gray, calcareous, sericitic shales occur as interbeds in the limestone at the base of the Shady. The contact between the Shady and Rome formations is placed at the base of very dark-gray, fine-grained limestone beds containing gray or black, locally oolitic, nodular chert which underlie the lowest maroon shales of the Rome Formation (not exposed in Section 2; see Appendix). Within the quadrangle the Shady Formation is between 1,100 and 1,200 feet thick and includes a limestone unit and two massive dolomite units.

The Shady Formation occurs in a topographically low area between steep quartzite ridges of the Antietam Formation and low shale ridges of the Rome Formation. The lower unit is commonly obscured by quartzite talus from the Antietam Formation, and in some areas terrace gravels cover the formation. Good exposures occur only in bluffs by the Shenandoah River and along Dog Run in the north-central portion of the quadrangle. A complete or nearly complete sequence of Shady strata is moderately well exposed on the north side of Calmes Neck (Appendix, Section 2). Good exposures of the upper and middle parts occur south of Lockes Landing in a faulted sequence on the south side of the northern meander neck.

The lower unit of the Shady Formation is composed of approximately 325 feet of dark-gray to black, very fine-grained, thin- to very thin-bedded limestone and dolomitic limestone with argillaceous laminations and orange or tan limestone or dolomite stringers and blebs. The lower unit grades into the middle part of the Shady that is composed of 60 feet of mottled medium- to light-gray, locally cream-colored dolomite overlain by 150 feet of very light-gray to buff, medium-grained, very thick-bedded to massive, high-magnesium dolomite (Figure 15), a lithology that is restricted to the Shady Formation. The upper unit of the for-

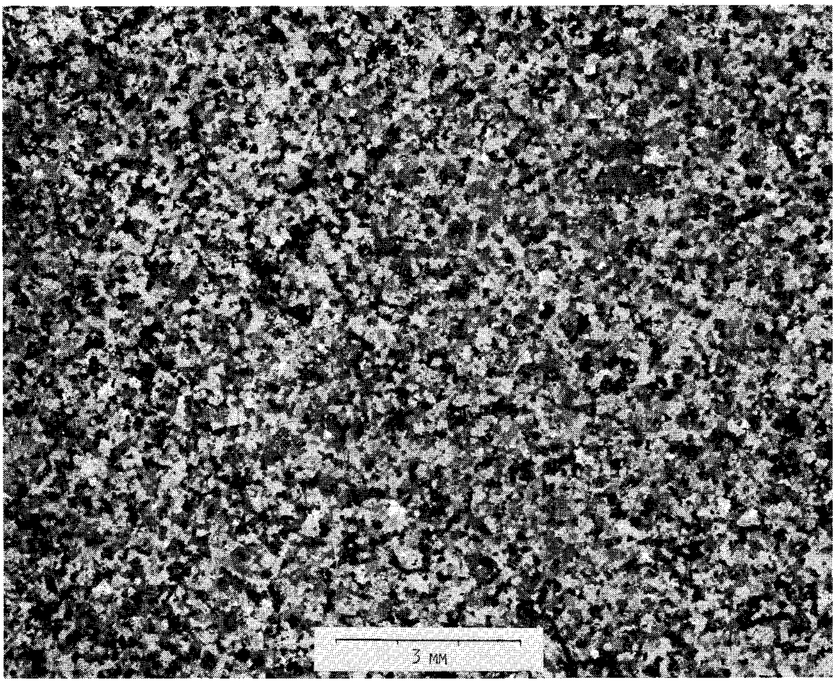
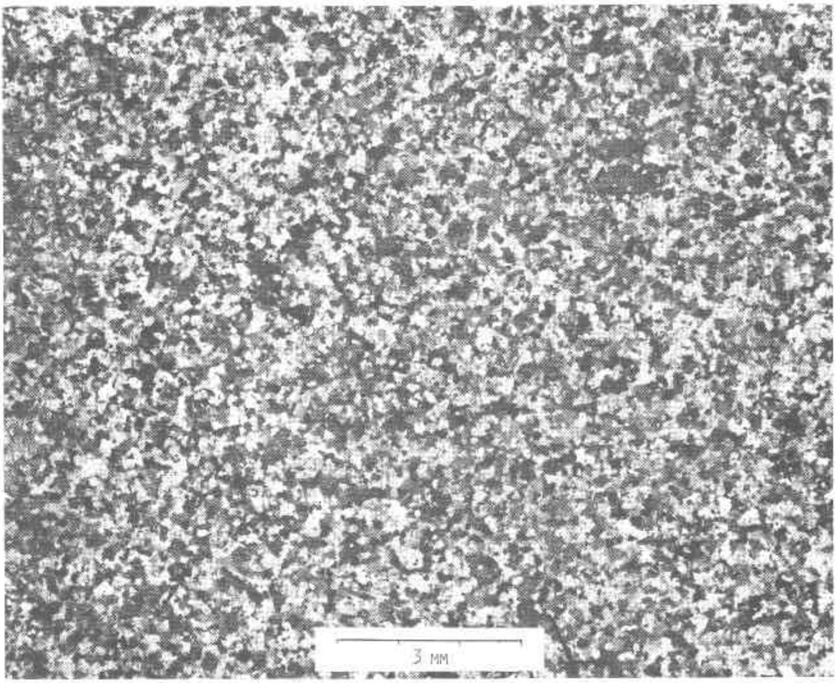


Figure 15. Photomicrograph of high-magnesium dolomite (R-5213) from the Shady Formation on the north side of State Highway 7, approximately 400 feet west of Castlemans Ferry Bridge in the Berryville quadrangle. This cream-colored, fine-grained, equigranular, crystalline dolomite, which is typical of the high-magnesium dolomites of the Shady Formation, exhibits no deformational fabric in thin section, although it is well-fractured in outcrop and located only a few feet from a reverse fault; crossed nicols; (compare with Figure 21).

mation is made up of approximately 600 feet of light- to dark-gray, fine- to coarse-grained, medium- to thick-bedded, locally laminated dolomite. White chert rosettes and nodules occur in the upper 50 feet of dolomite, and a few beds of yellow-weathering, laminated dolomite are present locally. The upper unit also contains a few feet of buff to white, coarse-grained dolomite with dispersed coarse, angular, quartz grains interstratified with medium- to thick-bedded gray dolomite.

ROME FORMATION

The Rome Formation consists of alternating limestones, dolomites, and vari-colored shales and other fine-grained, clastic



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ROME FORMATION

The Rome Formation consists of alternating limestones, dolomites, and vari-colored shales and other fine-grained, clastic rocks. Its boundaries are comformable and gradational with the underlying Shady Formation and the overlying Elbrook Formation. In this report the lower boundary is placed at the base of the first dark-gray, chert-bearing limestones (not exposed in Section 2; see Appendix) above the massive dolomites of the Shady Formation. The upper boundary is placed at the top of the green shale beds overlying the uppermost limestones containing blebs and stringers of dolomite. The Rome Formation is approximately 2,200 feet thick, of which 15 to 20 percent is dominantly clastic with the remaining 80 or 85 percent mostly carbonate.

Two resistant clastic units occur in the lower and middle portions of the Rome and are approximately 200 and 350 feet thick respectively. They are comprised of maroon, brown, and green shale, siltstone, and sandstone (Figure 16) with a few beds of

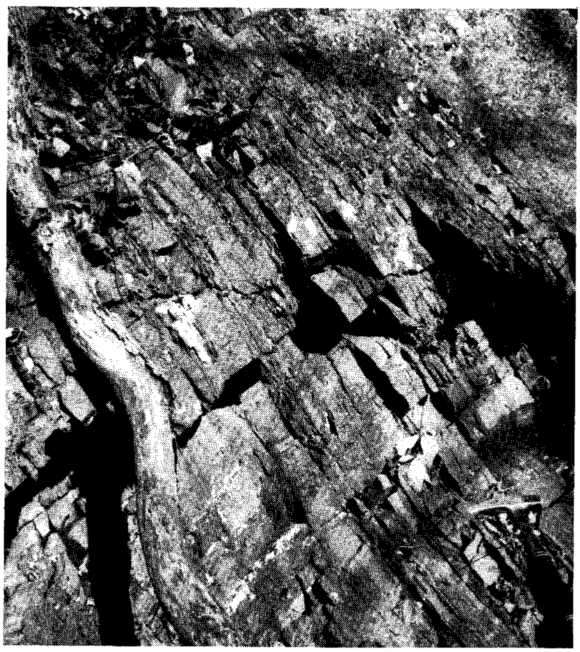

Figure 16. Sandstone and shale of the Rome Formation (upper clastic unit) as exposed 4,500 feet south of Lockes Landing, on the south side of the northern meander neck. These beds include thin-bedded, gray, fine-grained, quartz sandstones and argillaceous quartz sandstones overlain by laminated, drab-maroon shale and sandy shale.

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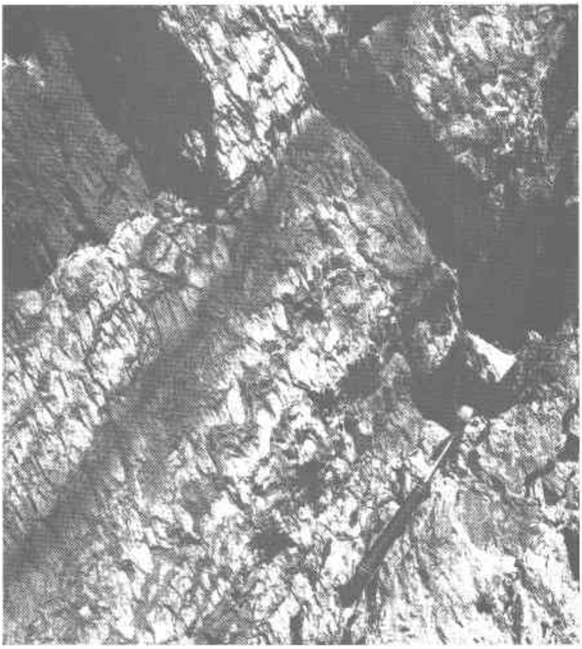
Figure 17. Argillaceous limestone of the Rome Formation as exposed 3,500 feet south-southwest of Lockes Landing, on the west side of the northern meander neck. Very dark-gray, fine-grained, laminated, argillaceous limestone and shale overlie the upper clastic unit and commonly have well-developed axial-plane cleavage.

argillaceous limestone and sandy dolomite. The clastic units are separated by approximately 600 feet of dark-gray dolomitic limestone and very dark-gray limestone with nodular black chert and blebs of coarse-grained dolomite along bedding planes. These three units have a combined thickness of approximately 1,150 feet and form a sequence that compares in detail with the Waynesboro Formation as described in its type area (Root, 1968) at Waynesboro, Pennsylvania. Lithologic descriptions and thickness of the lower portion of the Elbrook Formation in the Waynesboro, Pennsylvania area (Root, 1968) suggest a close similarity with the upper limestone unit of the Rome Formation as mapped in the Ashby Gap quadrangle. As the name Waynesboro Formation has been used in many previous reports on the geology of northern Virginia (Brent, 1960; Butts, 1933, 1940-41; Edmundson, 1945;



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King, 1950), eastern West Virginia, and western Maryland, and as the Waynesboro and Rome formations have generally been considered as equivalent rock units, it must be emphasized that only the lower portion of the Rome Formation that includes the two resistant clastic units as mapped in Ashby Gap quadrangle appears to be equivalent to the Waynesboro Formation of Pennsylvania.

The clastic units, which form low, well-defined, sinuous to linear ridges, are mapped separately ("s" on Plate 1) to better illustrate the structural configuration of the unit. The clastic units grade vertically into the adjacent argillaceous limestone units.

The upper limestone unit of the Rome Formation is characterized by thin-bedded, yellow-weathering, dark-gray, very

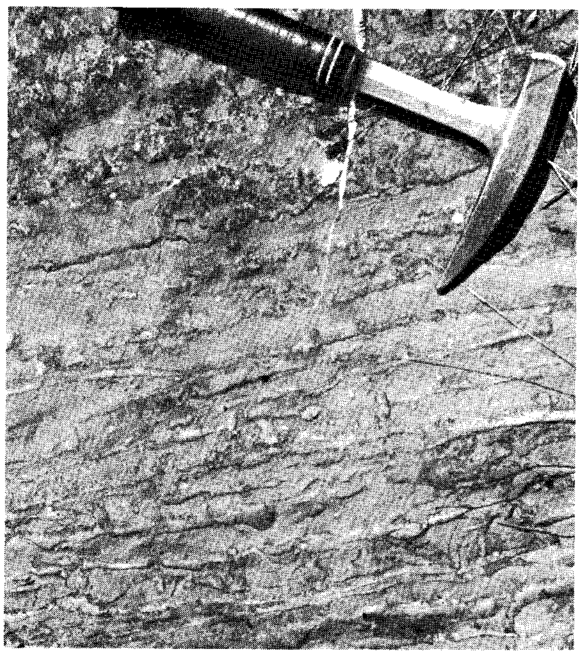

Figure 18. Medium gray, dolomitic limestone with blebs and stringers of light-gray dolomite defining bedding as exposed on hilltop 1,000 feet northwest of Lockes Landing. This lithology is common in the middle and upper limestone units of the Rome Formation. Good exposures of this lithology as it occurs in the middle limestone member are present on both the north and south sides of Calmes Neck.

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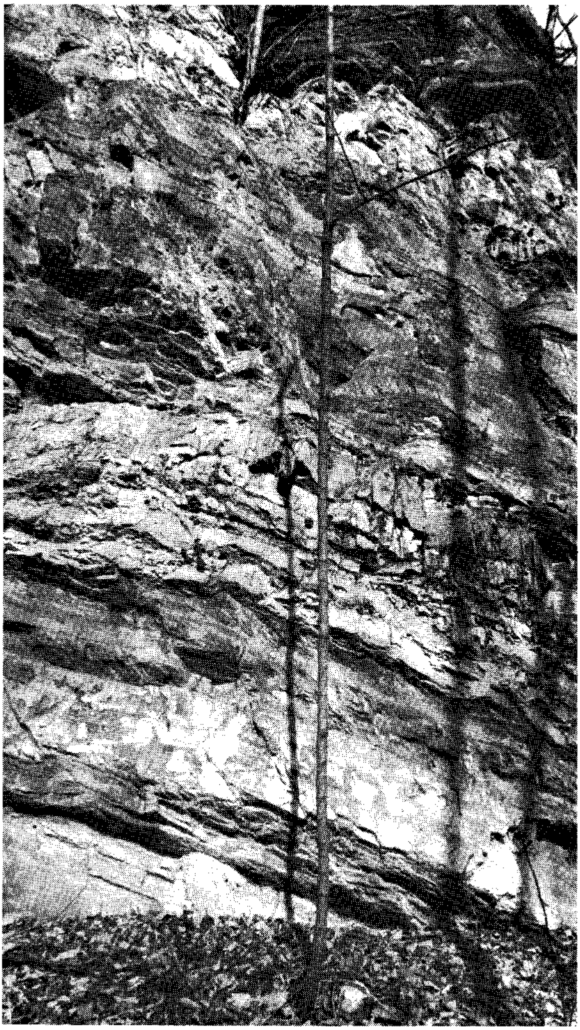
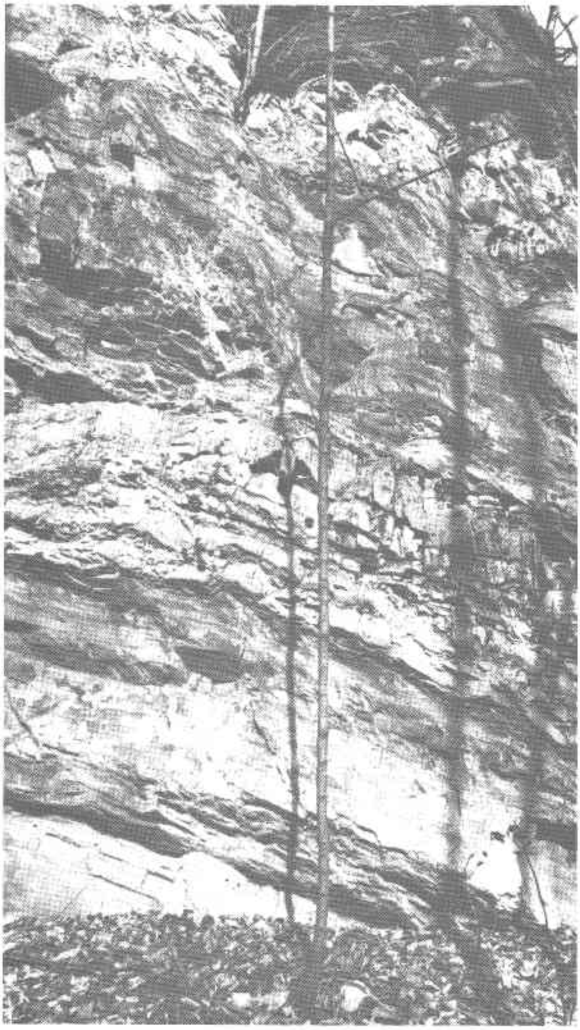


Figure 19. Lower clastic unit of the Rome Formation as exposed in the southeast limb of a broad anticline on the south side of Calmes Neck. The unit consists of laminated, argillaceous dolomite (the lighter gray, massive, or jointed beds in the photo) and interbeds of drab green, maroon, and tan shale (the darker gray, laminar beds). The best exposures of this unit in Ashby Gap quadrangle occur at this locality.

fine-grained, argillaceous limestone (Figure 17); and medium-gray, medium-grained limestone with blebs and stringers of light-



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fine-grained, argillaceous limestone (Figure 17); and medium-gray, medium-grained limestone with blebs and stringers of light-gray, coarse-grained dolomite that weather in relief and define bedding (Figure 18). A few ledges of light, tannish-gray, laminated, commonly argillaceous dolomite similar to dolomite beds of the Elbrook Formation are also present in the upper limestone unit and in the lower clastic unit (Figure 19). The upper limestone unit contains several thin, discontinuous, widely separated, maroon or drab green shale beds. The upper contact of this unit and of the Rome Formation is placed at the top of the most prominent shale occurrence, a sequence of drab green and locally maroon shales ranging up to 30 feet in thickness.

The lower half of the Rome Formation is well exposed on the south side of Calmes Neck in the bluff along the Shenandoah River. The middle and most of the upper portions are best exposed along the Shenandoah River in bluffs on the southwest side of the northern meander neck south of Lockes Landing. In each of the above areas the formation is folded, but the stratigraphic sequence is discernible. The much-folded upper unit is well exposed on Elersly Farm between Chapel Run and State Road 617. The shale beds that mark the top of the formation are exposed in roadcuts at the entrance to Stubblefield Farm on State Road 617, approximately 4,000 feet southeast of its intersection with State Road 618.

ELBROOK FORMATION

The Elbrook Formation consists of interstratified laminated limestone, laminated dolomite, calcareous or dolomitic siltstone, and varicolored shale beds. It is approximately 2,000 feet thick and is conformable with and gradational into both the underlying Rome Formation and the overlying Conococheague Formation. Good exposures of the unit occur along Lewis and Chapel runs and along State Road 617 southeast of its intersection with State Road 618 at the Elbrook-Conococheague contact.

The formation consists of bluish-gray weathering, medium- to dark-gray limestone with argillaceous laminae; light-tan to very light-gray weathering, light- to medium-gray laminated dolomites; and rusty-brown to buff-weathering, laminated, calcareous or dolomitic shales. A few thin, green, reddish-brown, and maroon shale and siltstone beds occur locally in the formation. A small amount of very fine-grained sandstone is present. The formation is relatively nonresistant to weathering and forms low, rolling ridges and hills except near the Shenandoah River where local relief is nearly 150 feet. A concentration of thin shale and argillaceous dolomite beds near the middle of the formation form a low, broad ridge with about 80 feet of relief that can be traced across most of the quadrangle. Some limestone beds contain nodular, medium-gray to white chert that locally may be traced for a few thousand feet. The formation is characterized by its laminated bedding and by rapid alternation between beds of laminated limestone, dolomite, and calcareous shale that are commonly 1 to 5 feet thick. Algal structures (stromatolites) are present in some of the dolomites; one such occurrence is on the north side of State Road 618 approximately 100 feet west of its intersection with State Road 613.

CONOCOCHEAGUE FORMATION

Only the lower 800 to 1,000 feet of the Conococheague Formation is present in the Ashby Gap quadrangle, and this occurs in the Pigeon Hill syncline east of U. S. Highway 340 and in the Franklintown syncline east of State Road 613. The Conococheague Formation is lithologically gradational with the Elbrook Formation, and the lower contact is placed at the base of the stratigraphically lowest occurrence of quartz sandstone. A concentration of quartz sandstone beds and sandy chert near the base of the formation forms a nearly continuous low ridge that topographically delineates this contact with the Elbrook Formation. These friable sandstones are light-tan, medium- to coarse-grained, buff-weathering and calcareous, and occur as thin- to medium-bedded, festoon cross-laminated interbeds in dark-gray, fine-grained, ribbon-banded limestones with dolomitic siltstone laminae. In this quadrangle the sandstones comprise only 1 to 2 percent of the Conococheague Formation. These lower sandstone beds may be equivalent to the Big Springs Station Member (Wilson, 1952, p. 307-308) of the Conococheague Formation as it has been mapped in West Virginia, Maryland, and Pennsylvania, but has not been differentiated for this report.

Most of the Conococheague Formation in the Ashby Gap quadrangle consists of ribbon-banded limestone with lesser amounts of laminated limestone and dolomite, intraformational limestone conglomerate, and stromatolitic limestone. The best exposures of these lithologies occur approximately 3,200 feet south of Pigeon Hill along the major tributary of Lewis Run on Llewelen Farm. The ribbon-banded limestone (Figure 20) is thin-bedded and dark-gray, with undulatory dolomitic siltstone interbeds rang-

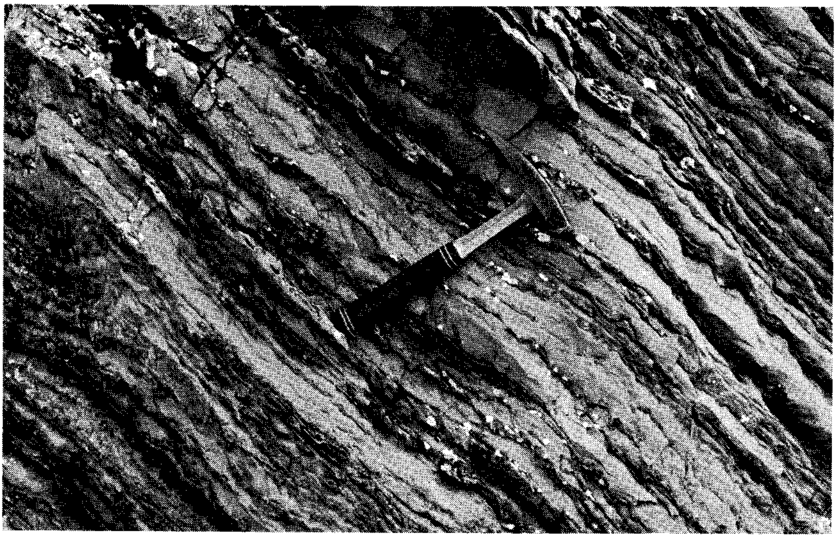


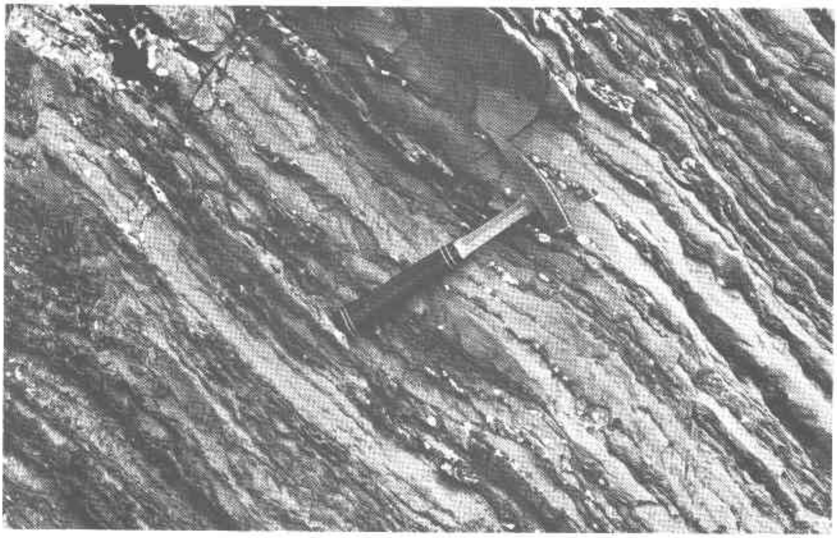
Figure 20. Conococheague Formation as exposed on private drive into Llewelen Farm 900 feet east of Norfolk and Western Railway, 2,900 feet south of Pigeon Hill. The best exposures of this formation in Ashby Gap quadrangle occur along this drive. The lithology consists of very fine-grained, crystalline limestone with thin, interbedded or interlaminated, silty or sandy dolomite or calcareous dolomite as shown above. There are also a few thin interbeds of light-tan weathering, medium-to coarse-grained, calcareous, quartz arenite and laminated gray shale.

ing up to about 1 inch in thickness that produce the banded appearance. The intraformational limestone conglomerates may be as thick as 4 feet and contain subrounded, elongate or plate-like limestone pebbles in a fine-grained crystalline limestone matrix. Thin beds of laminated, yellow-weathering dolomite and bluish-gray weathering limestone occur locally, as does gray shale with a prominent foliation. Ripple marks, mudcracks, mat-type stromatolites, and soft-sediment deformation features are common.

QUATERNARY SYSTEM

TERRACE DEPOSITS

Remnants of alluvial deposits in the form of intricately dissected terraces less than 20 feet thick are present along the Shenandoah River, usually at elevations less than 200 feet above river level. The terrace material generally occurs on bedrock of the Cambrian carbonate formations, but locally small areas un-



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ALLUVIUM

The subhorizontal deposits of alluvium that form the present flood plain of the Shenandoah River seem to differ from the older terrace deposits only in that they are younger and relatively undissected (Hack, 1965). Where the river is corrading flood-plain deposits in the Ashby Gap quadrangle, thicknesses of 15 to 20 feet of poorly sorted sediments are locally exposed in river banks and appear to be graded from pebble-cobble material at the base to sand and sandy silt at the top of the banks.

The flood-plain alluvium is composed of dark-gray quartz sand, silt, and clay with beds of cobbles and medium- to small-sized pebbles of quartzite, limestone, dolomite, and metabasalt. The base of the flood-plain deposits was generally concealed during the summer and fall of 1972 due to flooding and high-water levels of the Shenandoah River. Data obtained from 51 boreholes along a 1,200-foot north-northwest traverse across the Shenandoah River and portions of the flood plain immediately north of Byrd Bridge on U. S. Highway 50 were supplied by the Virginia Department of Highways. Data from these borings indicate that the thickness of the alluvial material ranges from 2 feet in the river bed to more than 20 feet on the west bank of the river. The alluvium is composed of pebble-bearing sand, silt, and clay underlain at most borehole sites by 1 to 8 feet of quartzite pebbles and cobbles in a sand and silt matrix. As the relatively shallow Shenandoah River flows directly on bedrock along most of its course through the Ashby Gap quadrangle and the surface of the flood plain is generally less than 20 feet above bedrock exposed in the river bed, the flood-plain deposits are probably less than 20 feet thick.

In the Shenandoah Valley deposits of tufa are common along spring-fed streams issuing from the carbonate uplands. One such deposit is cut by State Road 621 approximately 1,600 feet west of Lockes Landing and is a dark brown, impure, porous calcium-carbonate mass containing organic debris and fine-grained siliceous sediment. This tufa deposit has formed along the banks of a spring-fed stream incised in flood-plain alluvium, and may partially cap the alluvium near the stream.

Discontinuous deposits of cobbles and boulders (debris fans) cover the flood plains in the upper reaches of streams along the east and west foot of the Blue Ridge mountains. These deposits generally straddle outcrops of the Weverton Formation along the west foot of the Blue Ridge and the Swift Run Formation along the east foot, and tend to grade headward into talus and scree developed on slopes underlain by the Catoctin or Weverton formations. Due to the large size and angularity of much of the boulder material, and the distances (nearly 1 mile in places) that much of this material has been transported from its bedrock source, it is believed that these deposits are at least in part the result of ancient landslides of the debris-avalanche type. The occurrence of debris-avalanches in the Blue Ridge of Virginia, during the August 1969 torrential rains of Hurricane Camille, resulted in the formation of debris fans and rubble deposits in the flood plains of small streams near the foot of the Blue Ridge (Virginia Division of Mineral Resources, 1969). Debris fans on both sides of the Blue Ridge in the Ashby Gap quadrangle contain much deeply weathered boulder material that suggests most of the deposits are quite old.

STRUCTURE

Ashby Gap quadrangle is located on the northwest flank of the gently northeastward-plunging Blue Ridge anticlinorium midway between the axes of the anticlinorium and the Massanutten synclinorium, the nearest major structure to the northwest. Compressional tectonic forces acting on the stratified rocks have produced a complex series of folds that dominate the structural aspect of the quadrangle. Northward-trending reverse faults and northwestward-trending, nearly vertical faults are present, and a well-developed southeastward-dipping, axial-plane cleavage pervades the less competent rock units.

FOLDS

Large, complex, north-northeastward-plunging, asymmetric and overturned folds are the dominant fold features in the Ashby Gap quadrangle. The three northwesternmost folds are the Pigeon Hill and Franklintown synclines, and the intervening Calmes Neck anticline (Plate 1). These folds at the surface involve the Rome, Elbrook, and Conococheague formations which contain many weak, ductile interbeds of shale and limestone. These units have been deformed in a manner characterized by the development of many subsidiary folds on the limbs of the major folds. The larger folds to the southeast are the Willow Lake and Taylors Hill synclines and the herein-named Slate Ridge anticline. These folds are not complex where they are expressed in the Antietam, Shady, and lower Rome formations, but in the upper Rome, Harpers, and Weverton formations they are marked by many subsidiary folds. The east limbs of anticlines are right-side up and have low-to-moderate easterly dips; the west limbs are very steeply dipping and at many places are overturned. Fold amplitude and wave-length range from less than 100 feet for mappable subsidiary folds to several thousand feet for the major fold structures. The folds generally plunge north-northeastward at 10 to 20 degrees, but the amount of plunge ranges from at least 35 degrees to less than 5 degrees. Flexural-flow folding (Donath and Parker, 1964) is apparent in many limestone outcrops in the carbonate sequence (Figure 21), but is not evident in the dolomites. Where interbedded limestones and dolomites have been tightly folded, as along the axis of the Calmes Neck anticline, the dolomites have been deformed by brittle fracture resulting in autobrecciation with some local flowage of breccia fragments. The down-plunge view of the fold structure suggests a significant thickening of some rock units in the hinge area of folds and thinning along the limbs. These observations indicate that flexural-

Figure 21. Small-scale flow folds in the lower limestone unit of the Shady Formation exposed on the north side of U. S. Highway 50, 350 feet west of Byrd Bridge in the 7.5-minute Boyce quadrangle. Similar but much larger-scale flow folds are characteristic of this unit as well as the limestone beds of the Rome and Elbrook formations where they occur near reverse faults and on overturned limbs of major folds.

flow was an active mechanism in the development of the fold structures.

As the several stratigraphic units in the quadrangle vary considerably in their composition, they have reacted in different ways to the deformational forces that affected the area. The thick sequence of massive dolomites in the Shady Formation and the overlying thinner bedded limestones, shales, and dolomites of the Rome Formation provide the greatest contrast in the effect of deformational forces on differing lithologies. The Shady Formation has been deformed mostly by flexural-slip folding (Donath and Parker, 1964) and brittle fracture, of which the steep-dipping reverse faults are an example; the Rome and overlying formations were deformed mostly by flexural-flow folding. The gradation between flexural-slip and flexural-flow folding may be seen in the down-plunge view of the fold structure where the lower Rome Formation is in normal contact with the Shady Formation. It is across this contact that the transition in style of folding (change in form and size of folds) is most apparent. Structural data obtained from the limited exposures of the Ca-

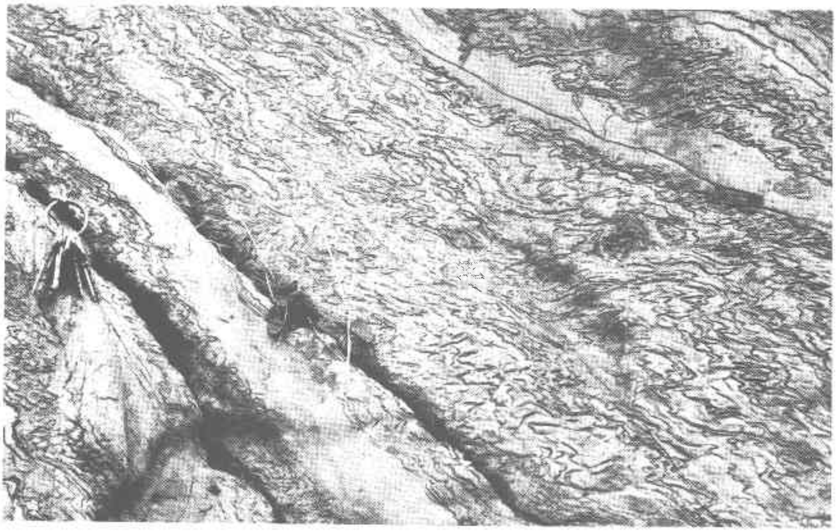

Figure 21. Small-scale flow folds in the lower limestone unit of the Shady Formation exposed on the north side of U. S. Highway 50, 350 feet west of Byrd Bridge in the 7.5-minute Boyce quadrangle. Similar but much larger-scale flow folds are characteristic of this unit as well as the limestone beds of the Rome and Elbrook formations where they occur near reverse faults and on overturned limbs of major folds.

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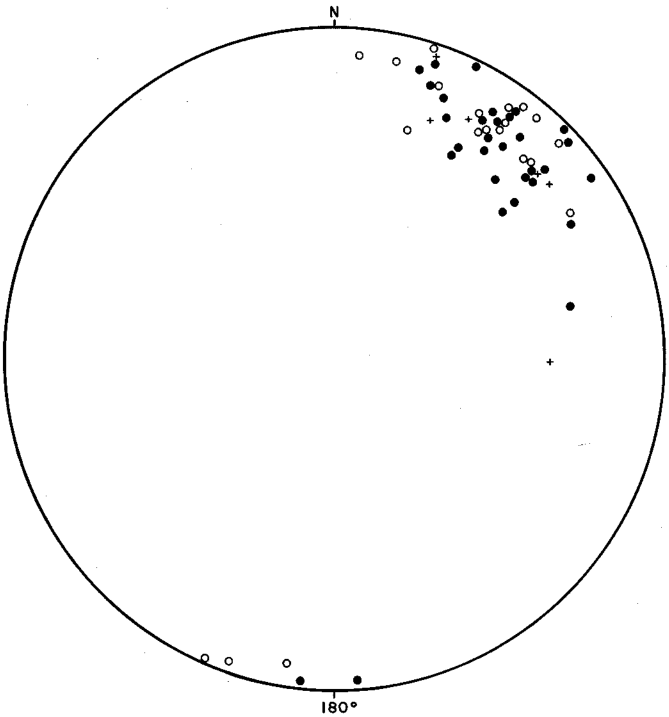

Figure 22. Cleavage-bedding intersections; lower-hemisphere, equal-area projections of the lineations formed by cleavage-bedding intersections constructed from measurements obtained from 59 outcrops. Lineation trends agree with the regional Blue Ridge cleavage-bedding lineation trend of approximately N. 35° E. (Cloos, 1971, p. 56, Figure 23). The greater concentration of northeastward-plunging lineations encountered in the Ashby Gap quadrangle are consistent with the northeastward-plunging fold structure of this portion of the Blue Ridge anticlinorium (Plate 1).

toctin Formation suggests that folds within this unit have an orientation similar to the folds observed in the Weverton Formation (Plate 1).

An equal-area projection of cleavage-bedding intersections in 59 exposures of the Catoctin and younger formations are shown in Figure 22. The projection of these intersections shows considerable variation but has a maximum density at approximately 15° to N.35°E.

FAULTS

In the Ashby Gap quadrangle four reverse faults trend about N.15°E. and have a relatively small displacement (less than 2,000 feet). The most prominent of these reverse faults is truncated at its southern end by a younger transverse fault just east of Byrd Bridge; this reverse fault occurs in rocks of the Antietam and Harpers formations at its southern terminus, but passes into successively younger formations to the north and dies out in the Elbrook Formation near the northern boundary of the quadrangle. The writers believe the fault to be an off-set continuation of the Blue Ridge border fault shown on the geologic map of Boyce quadrangle (Edmundson and Nunan, 1973, Plate 3). Also, it appears that the Blue Ridge border fault does not enter Ashby Gap quadrangle as shown on the geologic map of Boyce quadrangle, but encounters the aforementioned transverse fault northwest of Byrd Bridge in the Boyce quadrangle. This interpretation is suggested by the occurrence of an apparently normal succession of Harpers, Antietam, and Shady formations in the test borings adjacent to Byrd Bridge, with the Antietam-Shady contact occurring just west of the Shenandoah River (Plate 1). Tectonic quartzite breccias north of Byrd Bridge on the west side of the Shenandoah River are thought to be related to the transverse fault and not to the reverse fault.

A high-angle reverse fault is present from Bolden Hollow to just east of State Road 621 at the northern boundary of the quadrangle. This may be the same fault that occurs along the west flank of the Marvins Chapel anticline in the Berryville quadrangle (Edmundson and Nunan, 1973, Plate 1), although exposures near State Road 621 in the northern Ashby Gap and southern Berryville quadrangles are too few to establish this relationship. Another high-angle reverse fault occurs at the west end of Castlemans Ferry Bridge and appears to die out in the east flank of the Taylors Hill syncline to the southwest. Stratigraphic displacement along this fault is probably less than 1,000 feet. As reverse fault exposures can be directly observed at only a few localities in and adjacent to the quadrangle, the presence and location of the four reverse faults shown on Plate 1 is based largely on stratigraphic anomalies, changes in structural trends, and zones of intense deformation. Additional reverse faults of small displacement may be present in the Ashby Gap quadrangle along the axial portion of the Calmes Neck anticline and in the Reservoir Hollow area east of the Taylors Hill syncline.

A major linear topographic low that trends northwest from Rectortown in Fauquier County (southeast of the Ashby Gap quadrangle) to Millwood in Clarke County (west of the Ashby Gap quadrangle) is visible on topographic maps and aerial photographs, and extends through Paris and Ashby Gap in the southwest portion of the study area. The segment of this lineament in the Ashby Gap quadrangle west of the Catoctin-Chilhowee contact appears to be a nearly-vertical normal fault, downthrown on the southwest, or a left-lateral strike-slip fault. East of Paris the Swift Run Formation appears to be offset by a normal fault downthrown on the northeast or by a right-lateral strike-slip fault. Also, east of Paris the fault appears to separate the Precambrian granite (northeast side) from the augen gneiss (southwest side). As the augen gneiss body consistently lies to the west of both the Robertson River Formation and the granitic rocks of the Marshall Formation in the Flint Hill, Linden, and Upperville quadrangles to the southwest of Paris (personal communication, M. T. Lukert and E. B. Nuckols III, 1973), the fault displacement in the plutonic rocks appears to be left lateral. This condition, the apparent reversal of fault slip across time boundaries, suggests two or more periods of movement along this fault lineament.

A second northeastward-trending transverse fault, possibly genetically related to the first, passes through the Stuart M. Perry, Inc. quarry located west of Castlemans Ferry Bridge. This fault is nearly vertical, and appears to be downthrown on the northeast. In the quarry steeply westward-dipping dolomite beds of the Shady Formation are present in the southwest block, and gently northward-dipping beds of the same formation constitute the northeast block. Interpretation of aerial photographs suggests that this fault may be one of several subparallel, small-displacement faults trending west-northwest in the vicinity of State Highway 7 between Berryville in Clarke County and Bluemont in Loudoun County.

METAMORPHISM

In the Ashby Gap quadrangle all lithified stratigraphic units are foliated to some degree, indicating the entire sequence has been regionally metamorphosed (Turner, 1968, p. 264). However, the degree of recrystallization is relatively minor and primary

Table 2.—Characteristic mineral assemblages in metasediments of the Chilhowee Group and the Catoctin and Swift Run formations.

	Chilhowee Group													
	Antietam Formation			Harpers Formation		Weverton Formation			Catoctin Formation			Swift Run Formation		
	R-5210	R-5214	R-5215	R-5208	R-5209	R-5207	R-5216	R-5217	R-5218	R-5219	R-5220	R-5199	R-5200	R-5221
Quartz	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plagioclase	X	X	X	X	X						X	X		X
Microcline	X	X	X											
Perthite		X	X	X	X	X		X	X	X	X	X		X
Orthoclase	X	X	X	X	X				X					
Sericite	X	X	X	X	X	X	X	X	X		X	X	X	X
Chlorite				X	X		X				X	X	X	X
Epidote									X	X	X			
Magnetite (and ilmenite?)		X	X	X	X	X	X		X	X	X	X	X	X
Zircon	X	X	X	X	X	X	X		X	X		X	X	X
Tourmaline	X	X	X	X	X	X	X			X		X	X	

X denotes minerals present in samples.

Table 3.—Characteristic mineral assemblages in metavolcanics of the Catoctin Formation.

	Metabasalt				Rhyolitic metatuff					
	R-5222	R-5203	R-5223	R-5224	R-5225	R-5205	R-5226	R-5227	R-5228*	R-5202
Plagioclase	X	X	X	X	X	X	X	X	X	X
Actinolite	X	X	X	X						
Epidote	X	X	X	X	X	X	X	X	X	X
Chlorite	X	X	X	X				X		X
Magnetite (and ilmenite?)	X	X	X	X	X	X	X	X	X	X
Saussurite	X	X	X	X						
Quartz		X	X	X	X	X	X	X	X	X
Sericite				X					X	X
Microcline					X	X	X	X	X	X
Perthite							X		X	X

X denotes minerals present in samples.

*Sample locality not indicated on Plate 1.

features such as bedding, cross-bedding, cobbles, fossils, phenocrysts, amygdules, and vesicles are well preserved. The Chilhowee Group and older rock units are characterized by mineral assemblages of the lower greenschist facies (Winkler, 1967, p. 95; Turner, 1968, p. 270), and the mineralogy of typical samples from these units is summarized in Tables 2, 3, and 4.

In addition to the characteristic greenschist mineral assemblages there is a metamorphic aspect to the rock textures, but with the exception of the phyllitic rocks, the dominant textural features are primary (premetamorphic). For example, the groundmass of the metabasalts is dominated by randomly oriented plagioclase laths. These laths are very likely in their original form and distribution (Moorhouse, 1959, p. 443), with only their chemical composition and internal crystallography having been altered during metamorphism. Yet, the areas interstitial to the laths are occupied by randomly oriented actinolite

Table 4.—Characteristic mineral assemblages of the Precambrian granite rocks.

	R-5196*	R-5197	R-5229	R-5230*
Quartz	X	X	X	X
Perthite	X	X	X	X
Epidote	X	X	X	X
Magnetite (and ilmenite?)	X	X	X	X
Plagioclase	X		X	X
Microcline	X		X	
Sericite	X	X		X
Zoisite-clinozoisite				X
Chlorite	X	X		X
Zircon	X	X	X	X

X denotes minerals present in samples.

*Sample localities not indicated on Plate 1.

needles, globular masses of saussurite, ragged chlorite, scattered anhedral epidote grains, and fine-grained magnetite (and ilmenite?).

The rhyolitic metatuffs and the granitic rocks appear less altered than the metabasalts, which is undoubtedly due to the differences in original mineral composition of these rocks (Moorhouse, 1959, p. 442). The texture of the rhyolitic metatuffs is dominantly pyroclastic, but they do contain considerable epidote, and locally, sericite with a lattice-preferred orientation. Some of the Precambrian granites have an incipient cataclastic foliation which has been imprinted on a well-preserved, primary, medium-grained, granitic texture. Minor secondary minerals such as euhedral chlorite and magnetite (and ilmenite?) have grown across elements of the cataclastic foliation and thus postdate that foliation.

Texturally, the metamorphism of the Chilhowee Group and older rock units is most evident in the matrix-rich or very fine-grained metasediments (now phyllites) which are characterized by a prominent foliation. In thin section these rocks commonly have both a dimensional and lattice-preferred orientation of sericite and chlorite which dominates the matrix and defines the foliation. The rough parallelism of fold axial-planes and the microscopic foliation suggests a genetic relationship between the folding and the regional metamorphism.

ECONOMIC GEOLOGY

INDUSTRIAL LIMESTONE AND DOLOMITE

The northwest quarter of the quadrangle is underlain mainly by carbonate rocks, some of which have potential commercial value. Edmundson (1945) described and discussed the limestones and dolomites of Clarke County and presented chemical analyses of many strata having industrial potential. In the Ashby Gap quadrangle the Rome, Elbrook, and Conococheague formations include impure (generally siliceous or argillaceous) limestone, magnesian limestone, and dolomite. Interbeds of sandstone and shale and the common occurrence of chert in the carbonate beds of these formations reduce the potential for industrial use. Agricultural and crushed stone could be quarried from the thicker limestone and magnesium limestone beds of the Rome and Conococheague formations.

The Shady Formation is predominantly dolomite with interbeds of high-magnesium dolomite (Figure 15) and a lower member of magnesium limestone (Edmundson, 1945). Minor amounts of chert are present, but only in the upper 50 feet of the formation. The principal beds of high-magnesium dolomite occur just below the middle of the formation, above the dolomitic limestone of the lower member (Appendix, Section 2). These beds are well exposed in four places: on the north and south sides of Calmes Neck, in the crestal portion of an asymmetric anticline for about 800 feet along the south side of the northern neck, and on the north side of the Shenandoah River 1.5 to 1.7 miles southwest of Castlemans Ferry Bridge. These exposures include most of the 156-foot sequence of buff, massive dolomite beds in the middle member of the Shady Formation cited in Section 2 (Appendix). Analyses of these and other high-magnesium dolomite beds in this member in Clarke County (Edmundson, 1945; Edmundson and Nunan, 1973) show that much of the Shady dolomite averages about 42 percent magnesium carbonate with less than 3.5 percent noncarbonate impurities. High-magnesium dolomite is also exposed along State Road 621, 2,800 feet east of Lockes Landing, but is thought to be a portion of the upper member of the Shady Formation. Accessibility and transportation remain the only major inhibiting factors for development of these deposits. The Shady Formation is being utilized for agricultural lime and road aggregate at the Stuart M. Perry, Inc. quarry located 7,000 feet west of Castlemans Ferry Bridge on the northeast edge of the quadrangle.

IRON

Thin deposits of siliceous limonite occur locally in residual material over the lower limestone member of the Shady Formation where quartzite talus or river gravel deposits are present. This ore is exposed in several old exploration pits near the Shady-Antietam contact on the flanks of the Willow Lake syncline between Willow Lake and Calmes Neck. The pits may have been opened in an unsuccessful search for manganese ore during the last century. Very small deposits of siliceous limonite also occur locally in residual material over many of the limestone beds of the Rome and Elbrook formations where terrace deposits are present.

COPPER AND LEAD

The occurrence of copper has been reported at two localities in the Ashby Gap quadrangle. At one locality "Native copper associated with malachite occurs in small seams in epidotized Catoctin Greenstone" (Luttrell, 1966, p. 103). This locality is two miles northwest of Paris, Virginia on the Blue Ridge, and was reported by Keith (1894), but was not observed by the writers. The other occurrence, listed as the Frog Town prospect, is ". . . 4 miles south-southeast of Berryville on a north bend of the Shenandoah River . . ." (Luttrell, 1966, p. 51), and consists of traces of copper and lead minerals in the Shady Formation. This prospect was not located by the writers during the field investigation.

BARITE

Small masses of very coarsely crystalline barite occur in fractured dolomite and the overlying saprolite of the upper member of the Shady Formation in a fault zone exposed in the east wall of the Stuart M. Perry, Inc. quarry. Barite also occurs in fractures in quartzite of the Antietam Formation near an apparently small-displacement reverse fault exposed 7,500 feet east of Lockes Landing, on the north side of State Road 621 (Appendix, Section 1).

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APPENDIX

STRATIGRAPHIC SECTIONS

Section 1

Northeastward along State Road 621 approximately 0.8 mile north of Lewin Hill, Clarke County (Plate 1); beds have a strike of approximately N. 20° E. and a dip of 70° SE., overturned.

	Thickness Feet
Shady Formation	
12 Dolomitic limestone, very dark-gray, fine-grained, with orange-brown, silty limestone laminae and blebs	
11 Covered	85
Antietam Formation (483 feet)	
10 Sandstone and shale; weathered, iron-oxide cemented, brown, medium- to coarse-grained, friable, medium-bedded quartz sandstone with interbedded light-tan, weathered shale	18
9 Sandstone and quartzite, light-tan, drab to vitreous, medium- to fine-grained, thin, subparallel-bedded; locally arkosic quartz sandstone with very thin clay-shale partings	41
8 Covered; sandstone debris as above	39
7 Sandstone and quartzite; light-tan, medium- to fine-grained, thin-bedded, arkosic quartz sandstone and interbedded quartzite with clay-shale partings; fossil burrows and disturbed laminae occur in a few beds; crystalline barite coatings present on fracture surfaces near minor fault that occurs in this interval	94
6 Sandstone; light-tan, medium- to fine-grained, medium- to thin-bedded, arkosic quartz sandstone with a few beds of medium-grained quartzite; fossil burrows are abundant in the lower portion of this interval	63
5 Sandstone; tan, light-brown, and buff, medium- to very thin-bedded, fine-grained, arkosic quartz sandstone and minor interbedded quartzite	76
4 Sandstone; alternating tan, light-gray, and brown, medium- to fine-grained, very thin- to medium-bedded, locally arkosic quartz sandstone with abundant fossil burrows or disturbed laminae in the thicker beds; a few *Scolithus* tubes	43
3 Sandstone and shale; alternating medium- to very thin beds of light-brown and tan, medium- to very fine-grained, arkosic quartz sandstone, argillaceous, arkosic quartz sandstone, and green and tan shale; very minor amount of buff, fine-grained, quartz sandstone with subhorizontal fossil burrows, disturbed bedding laminae, and abundant *Scolithus* tubes	87
2 Covered; sandstone and shale debris as above	22

Harpers Formation

1	Covered; brown, green, weathered, argillaceous quartz sandstone and shale debris	

Section 2

Along Shenandoah River on the north side of Calmes Neck, Clarke County (Plate 1); beds have a strike of approximately N. 20° E. and are nearly vertical.

Rome Formation

15	Sandy siltstone and shale, drab-maroon, undulatory laminated bedding	5
14	Mostly covered; yellow-weathering shale debris near top; a few exposures of medium-gray, fine-grained, laminated dolomite and gray chert debris in lower half	251
13	Dolomite, drab-black, fine-grained, some laminated; and limestone with red-brown weathering argillaceous laminae	25

Shady Formation (1126 feet)

Upper unit (608 feet)

12	Covered; minor white chert debris	41
11	Dolomite, buff-weathering, light- to medium-gray, fine-grained, laminated to thick-bedded; local white, coarse-grained dolomite blebs and stringers along bedding; approximately 20 percent exposure	233
10	Dolomite, dominantly medium-gray with some dark-gray and buff, fine- to medium-grained, thick-bedded, locally laminated; approximately 40 percent exposure	334

Middle unit (high-magnesium dolomite) (218 feet)

9	Dolomite, buff to light-gray, medium- to fine-grained, massive (high-magnesium dolomite of Edmundson, 1945)	156
8	Dolomite, medium-gray, fine-grained; undulatory laminations and white, coarse-grained ovoid or lenticular dolomite segregations	62

Lower unit (300 feet)

7	Limestone, medium-gray, fine-grained; light-gray, coarse-grained blebs or stringers of dolomite	4
6	Limestone, black, fine-grained, dolomitic; reddish-brown, argillaceous limestone blebs and stringers	104
5	Limestone, medium-gray, fine-grained; dark-gray, medium-grained dolomite blebs or stringers; very thin bedded	9
4	Limestone, black, fine-grained, thin-bedded; reddish-brown calcareous bedding partings	73
3	Limestone, dark-gray, fine-grained; argillaceous partings, folded	60±
2	Covered; limestone debris as above	50±

Antietam Formation

1 Sandstone, buff, medium- to fine-grained; quartz sandstone and arkosic quartz sandstone debris ....

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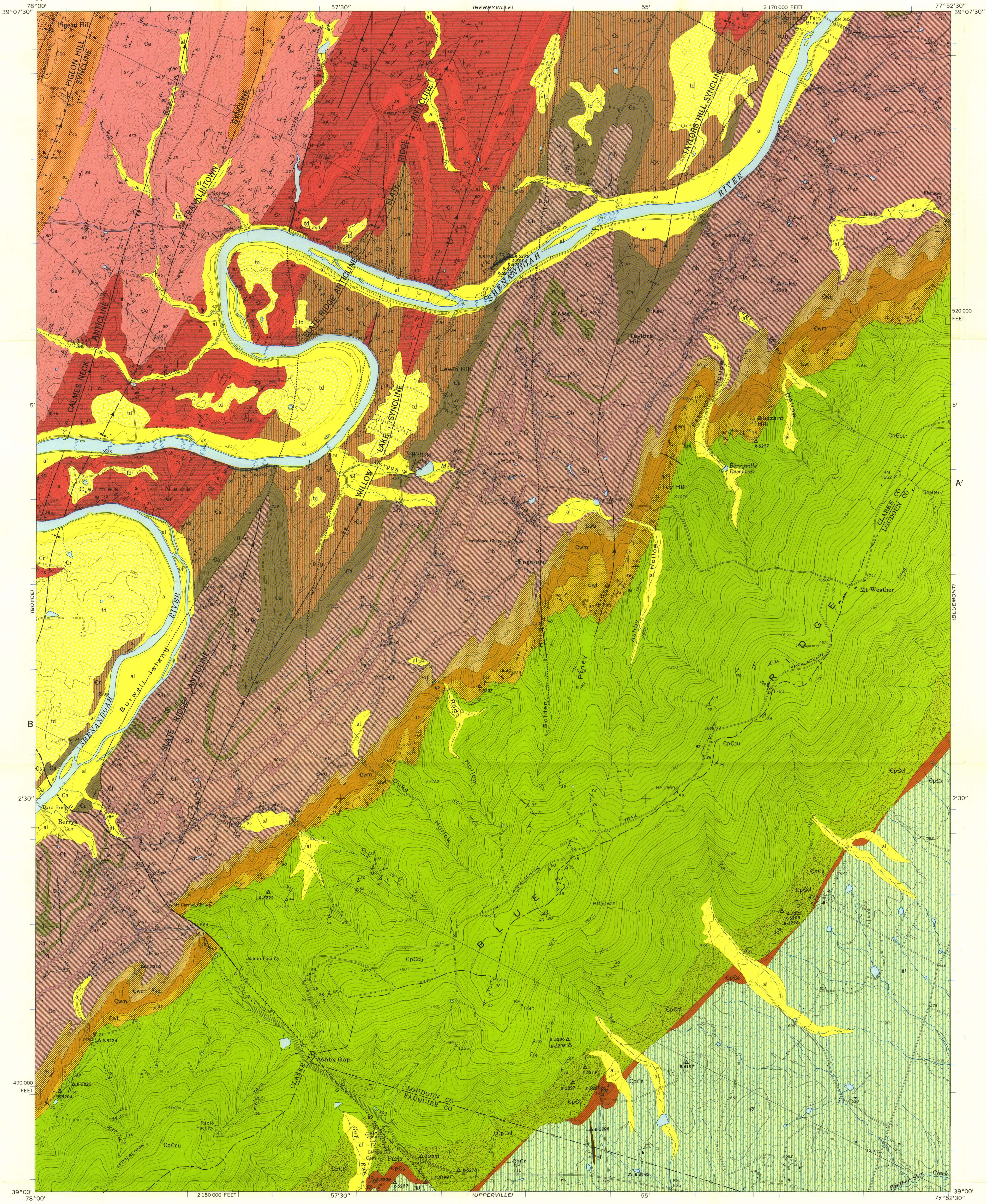

Base map from U. S. Geological Survey 1970, Ashby Gap Quadrangle, 7½-Minute Series

Williams & Heintz Map Corporation

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GEOLOGIC MAP OF THE ASHBY GAP QUADRANGLE, VIRGINIA

Geology by Thomas M. Gathright, II and Paul G. Nystrom, Jr.

MN GN
6° 107 MILS
1°51′ 33 MILS
UTM GRID AND 1970 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

VIRGINIA
QUADRANGLE LOCATION

1974

EXPLANATION

CENOZOIC — QUATERNARY

al — **Alluvium**
Dark-gray sand, silt, and clay with cobble and pebble beds at base along the Shenandoah River; discontinuous boulder and cobble deposits in stream beds along the east and west foot of the Blue Ridge.

td — **Terrace deposits**
Weathered gravel and cobbles in sand, silt, and clay matrix.

PALEOZOIC — CAMBRIAN

Ꞓco — **Conococheague Formation**
Dark-gray limestone with dolomitic siltstone laminae; intraformational limestone conglomerate; light-tan, medium- to coarse-grained, friable quartz-sandstone beds and sandy chert near base.

Ꞓe — **Elbrook Formation**
Medium- to dark-gray, laminated limestone with lesser amounts of interbedded light to medium-gray, laminated dolomite and a few beds of maroon and green shale, calcareous shale, and very fine-grained sandstone.

Ꞓr, s — **Rome Formation**
Dark-gray, yellow-weathering argillaceous limestone; medium- to dark-gray dolomitic limestone and light tannish-gray laminated dolomite; thin, discontinuous, maroon and green shale beds in upper limestone unit of formation; nodular black chert is common in the limestones and dolomitic limestones; s, *maroon, green, and tan shale, siltstone, and lesser amounts of sandstone comprise two resistant clastic members in lower part of formation.*

Ꞓs — **Shady Formation**
Medium- to light-gray, locally cream-colored, medium- to fine-grained, thick-bedded to massive dolomite; yellow-weathering, laminated dolomite and chert-bearing dolomite occur locally in upper part; high-magnesium dolomite and laminated dolomitic limestone occur in lower part.

Ꞓa — **Antietam Formation**
Tan to light-brown, very fine- to fine-grained feldspathic quartz sandstone and interbeds of light tan, medium- to very fine-grained, feldspathic quartz sandstone; lesser amounts of interbedded orthoquartzite, arkose, and sandy sericitic phyllite; Scolithus tubes and molds of probable fossil shell fragments occur locally.

Ꞓh, q, fs — **Harpers Formation**
Dark grayish-green, very fine-grained, thick-bedded to laminated feldspathic graywacke and phyllite; q, *tan, medium- to coarse-grained orthoquartzite;* fs, *ferruginous sandstone and dark-purple, hematite- and magnetite-cemented, argillaceous quartz sandstone.*

Ꞓwu, Ꞓwm, Ꞓwl — **Weverton Formation**
Ꞓwu, *upper member: quartz-pebble conglomerate and orthoquartzite with thin interbeds of phyllite and ferruginous sandstone.* Ꞓwm, *middle member: dark-gray, sandy phyllite and interbedded phyllitic sandstone with minor quartz-pebble conglomerate.* Ꞓwl, *lower member: light-gray, medium- to coarse-grained, very resistant orthoquartzite with interbedded sandy phyllite and quartz-pebble conglomerate.*

ꞒpꞒcu, ꞒpꞒcl — **Catoctin Formation**
ꞒpꞒcu, *upper member: dark-green, massive metabasalts with thin beds of epidosite and purple amygduloidal slate.* ꞒpꞒcl, *lower member: reddish-purple tuffaceous phyllite with interbeds of dark-green amygduloidal metabasalt; white, pink, and light-tan to cream rhyolitic metatuff; and epidotized, quartzose metasedimentary rocks.*

ꞒpꞒs — **Swift Run Formation**
Dark brown, locally purple, sandy and pebbly, sericitic and chloritic phyllite; locally, metagraywacke and meta-arkose.

PRECAMBRIAN

gr, f — **Granite**
Light- to very dark-gray, medium-grained, massive to moderately foliated perthitic granite and perthitic syenitic granite; f, *light gray, very fine-grained felsic dike.*

CONTACTS

Dashed where approximate, dotted where covered or inferred

FOLDS

Anticline—trace of fold and direction of plunge

Syncline—trace of fold and direction of plunge

Overturned anticline—trace of fold and direction of plunge

Overturned syncline—trace of fold and direction of plunge

FAULTS

U D

Dashed where approximate, dotted where covered or inferred; tick mark indicates direction of dip; U, upthrown side; D, Downthrown side

BRECCIA

b Brecciated beds

ATTITUDE OF ROCKS

25 Strike and dip of beds

70 Strike and dip of overturned beds

Strike of vertical beds

CLEAVAGE

45 Strike and dip of cleavage

QUARRY

Active quarry

Stuart M. Perry Inc.—dolomite (crushed stone)

SAMPLE LOCATIONS

△ R-5210 Location and repository number of sampled lithology

△ F-887 Location and repository number of fossil sample

2 Location of measured stratigraphic section that is described in text